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COMPETITION IN THE FIELD MARKET FOR NATURAL GAS

By

LESLIE COOKENBOO, JR.

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LESLIE COOKENBOO, JR.
Associate Professor of Economics
The Rice Institute

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Needless to say, none of these persons is responsible for the results; and it would be surprising if any of them agreed with all that follows.

LESLIE COOKENBOO, JR.

Houston, Texas
November 1, 1957

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INTRODUCTION

ALMOST from the date of passage of the Natural Gas Act of 1938, there has been a recurrent legal controversy ver whether Congress intended in that statute to regulate eld prices of natural gas, as well as the prices charged by nterstate gas pipe lines for the gas they sell. More funda- nental than the question of whether field prices *were* sub- ected to regulation by the legislation, is whether such prices *hould* be regulated. A corollary question is how prices hould be regulated if regulation be desirable. These ques- ions have, inevitably, been closely intertwined in the con- nuing debates over natural gas legislation. It is with the rincipal economic question involved in this controversy that his study is concerned.

A. The Question at Issue

The legal issue of whether Congress did, in fact, intend to gulate field prices of gas charged by non-integrated pro- ucers to interstate buyers is of minor interest to us here. uffice it to say here that the Natural Gas Act delegates to e Federal Power Commission the duty to regulate "the le in interstate commerce of natural gas for resale for ulti- ate public consumption . . . for any use."[1] (Note that direct terstate sales are exempt.) At the same time "production nd gathering" of gas were specifically exempted.[2] The legal uestion has been whether prices paid to producers on sales r resale are regulable. In the *Phillips* case in 1954, the upreme Court decided that such prices were to be reg- ated.[3] And the controversy has now passed to the legisla- e area.

Neither is it the purpose of this study to answer directly e other questions on the desirability and types of regula-

tion. Rather our purpose is to analyze for this industry the central economic issue present in deciding whether any industry should be regulated, viz., whether there is "workable" (effective) competition present. To some, perhaps to most, economists the answer to this central economic issue would in itself tell us whether regulation is necessary. An affirmative establishment of the existence of effective competition would indicate that regulation is unnecessary; conversely, proof of the absence of competition would indicate the desirability of regulation. The reason for this is that in the absence of competition certain unfortunate economic results occur; these are the economic consequences of monopoly. In the presence of effective competition these undesirable consequences are absent. Apart from over-riding political, social, or ethical considerations, the presence or absence of the consequences of monopoly is, to many economists, the primary determinant of the need for direct regulation of prices and output. Should other than economic considerations prevail and a competitive industry be regulated or a noncompetitive industry not be regulated, these economists—with whom this writer is largely in sympathy—would warn us of the inevitable economic price which must be paid.

Such a black-and-white view of the necessity for direct regulation of industry may not be taken by all economists. Some might feel that the competition-monopoly issue is only one of several. However, a substantial majority of the profession undoubtedly considers the presence or absence of competition to be one primary question to be settled before proposing regulation, if not *the* question. For example, Senator Douglas laid great weight on the (in his view) lack of effective competition in the natural gas producing industry as he advocated price regulation:

> It is clearly apparent that we are dealing with an industry which is monopolistic in character from the well to the burner tip. The major oil companies and a few large independents . . . dominate the sale of natural gas in interstate commerce for resale. . . . There is no real or effective competition so far as the big producers and gatherers are concerned.[4]

Similar views were expressed by President Truman in etoing the Kerr bill, which was designed to exempt non-ıtegrated producers from regulation:

> The . . . characteristics of the natural-gas business impose natural limitations upon effective competition among sellers. Competition is further limited by the degree of concentration of ownership of natural-gas reserves. While there are a large number of producers and gatherers, a relatively small number of them own a substantial majority of the gas reserves. . . . Under these circumstances there is a clear possibility that competition will not be effective, at least in some cases, in holding prices to reasonable levels.[5]

Professor Galbraith has recently approved price regulation ecause gas production is "an administered price industry," ıd administered prices are not compatible with the exist-ıce of effective competition.[6]

Likewise, the minority of the House Committee which pproved the Harris-Fulbright bill of 1955, a proposal de-gned to end field regulation in part, claimed that it is lementary" that the "way in which the commodity natural s is supplied to consumers in any given area is necessarily onopolistic."[7]

On the other hand some economists feel that effective, orkable competition does exist in the field market for nat-al gas and that this is sufficient reason for not regulating. r example, Professor Lindahl has said that,

> . . . the degree of concentration appears to be on the low side. While by no means a perfect market, it would seem that workable competition can prevail in such a market in the

> absence of collusion. There seems to be no evidence of significant changes in the market structure in recent years which has weakened the competitive force.[8]

Hence Professor Lindahl approved the Harris-Fulbright bill.

Again, Professor McKie in approving such legislation stated that,

> The gas production industry has become highly interdependent. No part of it is insulated from the effects of competition. . . . If any gas producer should attempt to hold out for a higher price than the other producers, he will simply lose his market.[9]

While there is a divergence of opinion among these commentators as to the degree of competition, it is apparent that there is agreement that its presence or absence is significant, if not *per se* determinative of whether there should be regulation. Among economists who have discussed the matter, only Professor Glaeser has indicated some dissent from the belief that the degree of competition is an important matter in this controversy. Commenting on Lindahl's paper in 1955, he stated that consumers will get small comfort out of Lindahl's market analysis showing competition; and he endorsed cost regulation which, in his view, might well not create "so many oil and gas millionaires, though it might spoil a part of the market for that paragon of the motor age: the new Continental Motor."[10] However, in his 1957 text on public utilities, he has said that Congress must decide "whether the lack of competition is such as to require regulation to take its place."[11]

With the possible exception of Professor Glaeser, then, the economists who have written on the subject hold the presence or absence of competition in the field market for natural gas to be a factor of decisive importance in evaluating the need for regulation of field prices. It is the primary purpose

of this inquiry to attempt to determine, with such factual evidence as can be assembled, how competitive this market actually is. Is "gas production an administered price industry" (Galbraith) where there is "no real or effective competition" (Douglas)? Or is this market one where "workable competition can prevail" (Lindahl) and, where "no part . . . is insulated from the effects of competition" (McKie)?

In examining this question we shall first review briefly in the remaining pages of this introduction the meaning of "effective" or "workable" competition. Then we shall examine in order: the growth of the natural gas market and the history of field prices (Chapter I); the market structure (Chapter II); and other factors than market structure which may affect competition in gas production (Chapter III).

B. The Meaning of "Workable Competition"

While it is not necessary to examine exhaustively the meaning of the term "competition" here, it is in order to define the term as it will be used in this study. To some people (perhaps to most people) "competition" is a synonym for "rivalry"; in classical economics it was something very different. Classical economic theory proclaims the ideal market structure to be "perfect" competition, or in its less rigorous version, "pure" competition. A perfectly competitive industry is defined as one with an almost infinitely large number of small firms, none of which has sufficient capacity relative to the industry to be able to influence market price by changing its output. This is the required "market structure," that is, the required number and relative sizes of firms. As such, it is the most important characteristic. Perfect competition also requires freedom of entry for new firms into the industry (a significant patent would be incompatible with

perfect competition). As a result of free entry, profits can never be "abnormally" high for long. Lesser requirements of the textbook concept are perfect knowledge of the intentions and desires of sellers and buyers, perfectly homogeneous products, and, of course, the absence of collusion among buyers or sellers. In such a market, price is set by the interaction of "supply" and "demand." "Supply" reflects the amounts producers would sell at various prices, while "demand" reflects the amounts consumers would take at various prices. In a given period the market price will be that price at which the amount consumers will buy is equal to the amount producers will sell; at no other price can there be "equilibrium," since price will always tend toward this level.

Less rigorous and more realistic than perfect competition is "pure" competition, which will settle for a finite large number of firms (100 of equal size might give pure competition), relatively free entry, and some knowledge of market conditions. Such an industry might be agriculture, cotton textiles, or bituminous coal. A purely competitive industry achieves the results of perfect competition for all practical purposes.

There are many purported economic and political advantages to perfect and pure competition. Here we shall mention only the two principal economic advantages: (1) the proper allocation of goods and services among consumers in the short run when there is a given amount of capacity available in the industry; and (2) the proper allocation of resources to the industry over the long run as consumers' basic desires for the product change relative to their desires for other products.

Perhaps the first of these purported advantages can be most readily disposed of by pointing out what happens if some authority attempts to hold a market price at a level

other than that which would equate supply and demand. One example is in agriculture, where a price artificially held higher than a free market would bring has led to more production than consumers will take at that price. Conversely, a price held lower than that the free market would set will call forth more demand than producers are able to satisfy, e.g., price and rent controls during World War II. A corollary of price ceilings during war-time is rationing. Indeed, the function of price is nothing more or less than that of rationing scarce commodities among consumers. In the short run the purely competitive market sets price where less eager consumers get less or none of the product and less eager suppliers offer less or none of the product, while the more eager consumers and suppliers participate to a greater extent. In war we substitute rationing based on some ethical concept, perhaps share-and-share-alike, for free market rationing. Market rationing is based on individual consumers' desires and abilities to pay for various quantities of a given product, relative to their corresponding desires for other products. Some may think that some other rationing device like share-and-share-alike is more appropriate than rationing based on the economic ability and desire to pay which is reflected in free competitive market prices. This may be; but if such a system is substituted by an authority, then the authority must assume the pricing function formerly held by the market. If an authority sets price, say, below the market level for non-economic reasons it *must* assume the rationing function and choose those consumers who will and will not get the quantities they would have paid for under a free market. Even in a totalitarian state, government cannot effectively change consumers' basic desires simply by substituting its price for that which reflected those desires.

In the long run the perfect or purely competitive market

also allocates goods and services in accord with supply and demand. In the long run, however, allocation is not simply a matter of allocating supplies produced by a given capacity, but of changing an industry's capacity to produce as consumer choice changes. This the competitive market does through the operation of the price mechanism and through temporary periods of "abnormal" profits and losses. (Abnormal profits are profits higher than those available in industries of comparable risks and hence high enough to make investment in the industry in question attractive.) For example, assume that demand increases for the product of a particular industry. Where demand has increased, a properly functioning economic system should attract capital to the industry until the increased requirements of consumers are satisfied relative to their demands for other products. If there is an increase in demand in a competitive market, price rises initially. This in turn leads to higher-than-normal profits for existing firms; they, and perhaps new firms, react to the higher profits by expanding capacity. Since many firms react independently in the same way, the result is a multiple expansion of supply. The increase in supply tends to drive price down until profits return to a "normal" level. Hence in a competitive market high profits associated with increased demand inevitably carry with them the seeds of their own destruction; but whenever they appear, they exercise a significant and essential function in attracting more capital to the industry.

The opposite procedure may well have occurred in other industries in which demand has decreased (a well-worn example is the buggy vs. the automobile). A balancing of demand for the product in question with demand for other products occurs when the return on capital in the affected industries becomes about equal after allowing for any differ-

ences in risk. Output has then been expanded in the favored industry to a point where consumers are no longer willing to pay a price which will give (premium) profits sufficiently high to provide investors with the incentive to commit additional capital to that industry instead of to others.

In summary, the perfect or purely competitive market price mechanism attracts more capital after an increase in consumer demand up to the point where consumers are no longer willing to pay for more capacity. And this is precisely what should happen if consumer demand is to govern the allocation of resources. On the other hand, if competition were not present and a monopolist controlled the supply, he might well refuse to increase output when demand increased and instead earn the higher profits perpetually. Such profits would serve no useful function, and consumer choice could not operate. What are the characteristics of pure competition not present in monopoly that make all this possible?

In perfect and pure competition, there are so many alternative sources of supply available to buyers that no one firm has any control over the price. No one firm can arbitrarily raise its price above the market level and expect to sell anything because all buyers are informed about market conditions and know full well that they have many other opportunities to purchase at the market price. Hence no firm can earn economically useless monopoly profits in the short run at the expense of ill-formed buyers. Perhaps more important, in case of a market price increase, the resultant higher profits earned by all firms will serve the economic function of increasing capacity because of the combined effect of the presence of many firms and the possibility of entry into the industry. This increase in profits will be temporary because no one firm can control price; whereas a monopolist, free from fear of competitive retaliation, could raise price and leave it

there knowing that customers can take his price or leave it. The crux of the matter is the existence of a market structure including so many alternative sources of supply that no seller has any real power over buyers; hence no seller can make a take-it-or-leave-it offer with impunity.

At least since the 1930's, economists have been greatly concerned about the usefulness of the notions of perfect and pure competition as guides to public policies designed to regulate monopoly. No industries meet the structural requirements of perfect competition. Few may even be called purely competitive. Does this mean that all other industries necessarily fail to achieve competitive results? It has been recognized that the rigorous requirements of the theoretical concept of perfect competition are not a realistic guide to the determination of whether an industry actually achieves competitive results. And some economists have asserted that the desirable results of perfect and pure competition can be achieved with a much more realistic industrial structure, perhaps with very few large firms. According to them, if there are a number of real alternative sources of supply available to the consumer so that no one supplier has the extraordinary bargaining power that accrues from complete or partial control of the market, there is no reason why competitive results cannot be obtained. An industry where such is the case has been called one of "workable" or "effective" competition.

There is considerable disagreement among economists on how large the number of alternatives must be for effective competition to exist and on what other conditions are required.[12] An approximate consensus of the conditions required to give prices and profits like those in a purely competitive market is that:

(1) The market must be divided among a number of suppliers;
(2) No one firm may be sufficiently large to dominate the industry so that monopolistic, or partly monopolistic, behavior exists;
(3) Product differentiation among the suppliers must not be so great as to give any one supplier undue bargaining power in the distribution of his product (in other words, the products of firm A must be reasonably good substitutes for those of firm B);
(4) Entry into the industry should be relatively free so that existing firms face not only actual competition from other existing firms, but also the threat of potential new competitors should prices rise to such an extent that abnormal profits are earned;
(5) The several firms must operate independently of each other with neither tacit nor overt collusion; and
(6) There must be some knowledge by buyers and sellers of market prices for a number of transactions.

Of these conditions, the first is the most important. It is real alternative sources of supply which are the *sine qua non* of effective competition. There is some disagreement among economists (and among judges) as to just how *many* alternatives are required for workable competition; suffice it to say that more than a few are desirable, if not necessary. Regardless of the critical number, in evaluating the competitiveness of an industry the primary test is to examine its structure to see if sufficient alternatives exist so that no one supplier can arbitrarily raise the price. Other aspects of competition are of varying degrees of importance, but none exceeds this. Without free entry there could still be competition if there were enough existing companies. Even some tacit collusion need not obviate competitive results *in toto,* since (1) collusion is perforce informal because of the antitrust laws and hence may be ineffective and (2) the threat of potential competition may keep profits at a level low enough to make entry of new firms unattractive. It is unquestionably

better to have free entry and no collusion; but competition may exist in the absence of these conditions. Competition cannot exist in the absence of some real alternative sources of supply. Potential competition might possibly serve as a check on the actions of a single producer, but the existence of even a few firms means a very great improvement in the chances for achieving competitive results relative to the situation with only one firm.

Where there are many alternative sources of supply, with no firm dominant, competitive performance can be expected to exist. Indeed, in the absence of successful collusion, the establishment of the existence of competitive structure should be sufficient to predict with confidence that competitive results will obtain unless there are most unusual problems peculiar to the industry in question. Hence in examining the competitiveness of the field market for natural gas, major emphasis will be laid on its structure. In addition we shall evaluate profits, freedom of entry, and some unique competitive problems in the market.

CHAPTER I

PRODUCTION, CONSUMPTION, AND PRICES OF NATURAL GAS—1920-1955

IN THE decade following World War II, there has been almost explosive growth in the market for natural gas, both in total volume consumed and in the areas served. This rapid growth has affected the structure of the industry (the key determinant of competitiveness just discussed), the kind of customers served, and (most important) the level of field prices. Hence any inquiry into the competitiveness of the market requires some familiarity with the locale and volume of production, the several types of consumption, and the behavior of prices. These are the matters at hand. Furthermore, an understanding of changing patterns of consumption and production will help in understanding the fundamental cause of much of the controversy over regulation of the field price of gas. The recent rapid rise in prices is in large part responsible for much of the pro-regulation feeling in the consuming states. Since changes in the volume and geographical location of consumption are largely responsible for this price rise, it is well to comprehend what has happened to production and consumption over the years. To these ends this chapter will be concerned with the following for the period 1920-1955: (A) location and volume of production; (B) location and volume of consumption; (C) types of end uses; and (D) price behavior.

A. Location and Volume of Production

Today the bulk of natural gas production is in five states in the Southwest: Texas, Louisiana, Oklahoma, New Mexico,

Table I-1

Marketed Production of Gas in the United States by Principal States of Origin—1920–1955[1]

(Volumes in Billion Cubic Feet)

State	1920		1925		1930		1935		1940		1945		1950		1955	
	Volume	Per Cent of U. S.	Volume	Per Cent of U. S.	Volume	Per Cent of U S.	Volume	Per Cent of U. S.	Volume	Per Cent of U. S.	Volume	Per Cent of U. S.	Volume	Per Cent of U. S.	Volume	Per Cent of U. S.
Texas	37.1	4.6	134.9	13.5	517.9	26.6	642.4	33.5	1,063.5	40.0	1,711.4	43.7	3,126.4	49.8	4,730.8	50.3
Louisiana	58.3	7.3	152.6	12.8	278.3	14.3	249.5	13.0	343.2	12.9	542.8	13.9	831.8	13.2	1,680.0	17.9
Oklahoma	154.5	19.4	249.3	21.0	348.1	17.9	274.3	14.3	257.6	9.7	357.5	9.1	482.4	7.7	615.0	6.5
Kansas	21.1	2.6	26.9	2.3	37.6	1.9	57.1	3.0	90.0	3.4	146.0	3.7	364.0	5.8	471.0	5.0
New Mexico	—	—	X	X	9.5	0.5	27.9	1.5	64.0	2.4	105.0	2.7	212.9	3.4	540.7	5.7
Subtotal	271.0	34.0	563.7	47.4	1,191.4	61.3	1,251.2	65.3	1,818.3	68.4	2,862.7	73.1	5,017.5	79.9	8,037.5	85.5
California	66.0	8.3	187.8	15.8	334.8	17.2	284.1	14.8	352.0	13.2	502.4	12.8	558.4	8.9	538.2	5.7
West Virginia	239.7	30.0	180.3	15.2	144.2	7.4	115.8	6.0	188.0	7.1	160.2	4.1	190.0	3.0	212.4	2.3
Mississippi	—	—	—	—	0.2	X	9.6	0.5	6.4	0.2	4.6	0.1	114.2	1.8	163.2	1.7
Pennsylvania	125.8	15.8	101.6	8.5	88.7	4.6	94.5	4.9	121.2	4.6	149.1	3.8	91.1	1.5	99.2	1.1
Ohio	58.9	7.4	43.2	3.6	63.4	3.3	49.6	2.6	40.6	1.5	50.0	1.3	43.2	0.7	33.8	0.4
Others	36.8	4.6	112.0	9.4	120.7	6.2	111.8	5.8	133.7	5.0	189.7	4.8	267.7	4.3	321.1	3.4
Total U.S.	798.2	100.0	1,188.6	100.0	1,943.4	100.0	1,916.6	100.0	2,660.2	100.0	3,918.7	100.0	6,282.1	100.0	9,405.4	100.0

Notes: 1—Quinquennial Data.
X—Less than 0.05 billion cubic feet or 0.05 per cent
Source: Production from Bureau of Mines.

and Kansas (see Table I-1). Among them these states accounted for about 87 per cent of "marketed production" in 1955. (The term "marketed production" is used to describe gas produced and sold, as distinguished from "total production" which includes gas which is reinjected in fields to increase oil recovery, gas which is flared for want of a market, etc.) All five states are net exporters (see Table I-2). Texas,

TABLE I-2
STATES WHICH ARE NET EXPORTERS OF NATURAL GAS
(1955)

	Shipments	Receipts (MM c.f.)	Net Shipments	Per Cent of Total Net Shipments
1. Texas	2,564,598	103,934	2,460,664	58.71
2. Louisiana	1,001,289	102,469	898,820	21.44
3. New Mexico	374,626	51,287	323,339	7.71
4. Oklahoma	285,436	20,709	264,727	6.32
5. Kansas	382,881	239,887	142,994	3.40
Subtotal	4,608,830	518,286	4,090,544	97.60
6. W. Virginia	161,981	123,424	38,557	0.92
7. Wyoming	41,687	3,517	38,170	0.91
8. Mississippi	130,671	106,692	23,979	0.57
Total	4,943,169	751,919	4,191,250	100.00

Source: Shipments and receipts from Bureau of Mines.

the single largest producing state, accounts for about half the total. Another moderately important state in this vicinity is Mississippi, which provides 1.7 per cent of total production, an amount somewhat larger than its consumption. Other states producing more than 1 per cent of total are California, West Virginia, and Pennsylvania. Of these, California and Pennsylvania import far more gas than is produced locally. West Virginia and Wyoming are the only

states other than the five principal producers which are net t
exporters; neither contributes a very significant amount of f
gas to other states.

This concentration of gas production in the Southwest has s
not always existed. As is shown in Table I-1, only 34 per cent t
of total marketed production originated in the five states in
1920, and over half of this was from Oklahoma. West Virginia
was the largest producer at this time, as it had been for some
years. In 1910,West Virginia alone originated 38 per cent of
total marketed production, with Pennsylvania accounting
for 24 per cent.[13] West Virginia reached its peak share of the
market since 1906, the first year for which respectable sta-
tistics are available, in 1912-1913, having 42 per cent of the
market in those years. Pennsylvania's relative position had
decreased to 18 per cent by 1915, and even West Virginia's
share had begun to decline both in an absolute and relative
sense by 1920. In spite of a resurgence in production in West
Virginia after World War II, the *relative* decline has con-
tinued more or less uninterruptedly since 1920, until the
combined production of West Virginia and Pennsylvania was
only 3.4 per cent of total marketed production in 1955. On
the other hand, the marketed production of Texas grew from
less than 5 per cent of total in 1920 to over 26 per cent by
1930; its share of total has almost doubled since that time.
Likewise, the share of total marketed production originating
in the other four Southwest states has grown steadily over
the past 35 years.

This shift of production away from the Eastern heating
market can be expected to be rather permanent, at least for
the next twenty years or so. The Appalachian fields are of
little importance relative to total, and no startling new dis-
coveries are being made there. The bulk of the present proved

reserves, which will be the source of most production for the future, are found in the Southwest. This is shown in Table I-3, in which shares of proved reserves for the leading states at the end of 1955 are compared with their shares of marketed production in 1955. Note that the five states have a

TABLE I-3
SHARES OF PROVED RESERVES AND MARKETED PRODUCTION OF NATURAL GAS HELD BY LEADING PRODUCING STATES—1955

State	December 31 Reserves		Marketed Production	
	Volume (trillion cu. ft.)	Per Cent of U.S.	Volume (trillion cu. ft.)	Per Cent of U.S.
1. Texas	108.3	48.4	4.731	50.3
2. Louisiana	42.4	19.0	1.680	17.9
3. New Mexico	18.6	8.3	0.541	5.8
4. Kansas	16.3	7.3	0.471	5.0
5. Oklahoma	13.2	5.9	0.615	6.5
Subtotal	198.8	88.9	8.038	85.5
6. California	8.9	4.0	0.538	5.7
7. Wyoming	3.2	1.4	0.078	0.8
8. Mississippi	2.6	1.2	0.163	1.7
9. Colorado	2.3	1.0	0.049	0.5
10. West Virginia	1.6	0.7	0.212	2.3
Total of Ten	217.4	97.2	9.078	96.5
Others	6.3	2.8	.327	3.5
Total U. S.	223.7	100.0	9.405	100.0

Source: Reserve from American Gas Association.
Production from Bureau of Mines.

higher share of reserves than of current production (88.9 vs. 85.5 per cent). Unless a number of large fields are discovered outside of this area in the next few years, production will continue to be concentrated at a considerable distance from the major heating markets.

The second significant point that must be recognized in discussing gas production is the impressive increase in the volume produced and marketed, particularly in the five Southwest states. The following data from Table I-1 summarize this growth:

Rates of Change in Marketed Gas Production 1920–1955

Year	Southwest		Total U. S.	
	Production (Bil. cu. ft.)	Per Cent Change	Production (Bil. cu. ft.)	Per Cent Change
1920	271.0		798.2	
		+108		+48
1925	563.7		1188.6	
		+111		+64
1930	1191.4		1943.4	
		+ 5		− 1
1935	1251.2		1916.6	
		+ 45		+39
1940	1818.3		2660.2	
		+ 57		+47
1945	2862.7		3918.7	
		+ 75		+60
1950	5017.5		6282.1	
		+ 60		+50
1955	8037.5		9405.4	

Marketed production in the five states quadrupled during the 1920's, increased by over 50 per cent even during the depression years of the 1930's (with nearly all of this growth in the last half of the period), increased again by over 50 per cent during World War II, and almost tripled in the first ten postwar years. For the country as a whole, production in 1955 was well over twice that in 1945, about five times that in 1935, and about eight times that thirty years earlier in 1925. This represents a rate of growth far greater than that of the economy as a whole. Between 1920 and 1955

gross national product in constant dollars increased by 210 per cent, compared with the growth in gas production of 1,070 per cent. Likewise postwar growth in gas production has been more rapid than that of the economy. From 1945 to 1955, gross national product in constant dollars rose by about 21 per cent, and marketed production of gas rose by 183 per cent—again a rate of growth far greater than that for the economy as a whole. Most significant in evaluating the competitiveness of recent field price increases is the near tripling of output after World War II, since such a rapid rise in output is likely to lead to a rise in price unless productive capacity increases at the same rate. As will be seen below, this is precisely what has happened.

B. Location and Volume of Consumption

Not only has production of gas been concentrated in the Southwest since the mid-1920's, this area has also been the most important consuming area. Relative shares of consumption accounted for by the important producing states are shown in Table I-4. Observe that since the mid-1920's, the Southwest states have accounted for over 40 per cent of total consumption of gas in the United States; this, of course, is a figure far greater than the proportion of the total population which resides in those states (12 per cent in 1950). Because of widespread industrial use, including use in the fields for drilling, per capita gas consumption is far higher in the producing areas than in consuming areas distant from the gas fields.

Particularly important in evaluating pricing is the geographical shift in consumption which has occurred since World War II. Table 1-4 shows that while there was a marked postwar growth in gas consumption in the Southwest in the

TABLE I-4

CONSUMPTION OF GAS IN THE PRINCIPAL PRODUCING STATES—1920–1955[1]

(Volumes in Billion Cubic Feet)

State	1920		1925		1930		1935		1940		1945		1950		1955	
	Volume	Per Cent of U.S.	Volume	Per Cent of U.S.	Volume	Per Cent of U.S.	Volume	Per Cent of U.S.	Volume	Per Cent of U.S.	Volume	Per Cent of U.S.	Volume	Per Cent of U.S.	Volume	Per Cent of U.S.
Texas	49.5	6.2	142.5	12.0	447.6	23.1	525.7	27.8	874.3	32.9	1,348.1	34.6	1,824.6	30.3	2,236.5	24.7
Louisiana	46.2	5.8	148.0	12.5	132.0	6.8	151.9	8.0	185.1	7.0	325.9	8.4	475.5	7.9	774.3	8.5
Oklahoma	126.7	15.9	209.5	17.6	248.9	12.8	258.6	13.7	230.8	8.7	249.9	6.4	286.8	4.8	334.1	3.7
Kansas	33.1	4.1	48.7	4.1	65.6	3.4	72.8	3.9	96.8	3.6	160.4	4.1	242.6	4.0	309.0	3.4
New Mexico	—		X	X	12.4	0.6	18.4	1.0	40.2	1.5	71.5	1.8	147.5	2.4	215.3	2.4
Subtotal	255.5	32.0	548.7	46.2	906.5	46.7	1027.4	54.3	1427.2	53.7	2155.8	55.3	2977.0	49.4	3869.2	42.7
California	66.0	8.3	187.8	15.8	334.8	17.2	284.1	15.0	352.0	13.3	502.4	12.9	683.9	11.3	1,020.4	11.2
W. Virginia	100.3	12.6	74.3	6.3	62.9	3.2	53.8	2.9	77.5	2.9	88.8	2.8	132.2	2.2	158.0	1.7
Mississippi	—		—		4.4	0.2	8.8	0.5	17.7	0.7	38.3	1.0	76.9	1.3	138.2	1.5
Pennsylvania	161.4	20.2	119.5	10.1	108.2	5.6	91.6	4.8	121.2	4.6	149.1	3.8	263.2	4.4	390.3	4.3
Ohio	136.9	17.2	112.0	9.4	125.8	6.5	105.9	5.6	129.9	4.9	172.3	4.4	324.5	5.4	500.9	5.5
Others	78.1	9.8	146.1	12.3	399.0	20.6	319.3	16.9	529.1	19.9	793.8	20.3	1,568.7	26.0	2,993.3	33.0
Total U.S.	798.2	100.0	1,188.4	100.0	1,941.6	100.0	1,890.9	100.0	2,654.6	100.0	3,900.5	100.0	6,026.4	100.0	9,070.3	100.0

Notes: 1—Quinquennial Data.
X—Less than 0.05 billion cubic feet or 0.05 per cent.
Source: Consumption from Bureau of Mines.

first postwar decade (an 80 per cent increase for the five states from 1945 to 1955, or 6 per cent per year compounded), consumption in other areas has grown even more rapidly. From 1945 to 1955 consumption outside the five states increased by *194* per cent (11 per cent per year compounded). Hence the relative share of total consumption in the five states has declined since its 1945 peak of 55.3 per cent to 42.7 per cent in 1955. The significance of this shift to the problem at hand is that not only has there been a rapid increase in total production (as was discussed above), there has been a marked change in the *nature* of consumption as less of the total is consumed in the producing areas. This change in the nature of consumption will be discussed in the succeeding section.

Before proceeding to this question, it is in order to demonstrate further the magnitude of the growth in consumption of Southwest gas outside the five states. It is this great growth of the interstate market of natural gas that has brought the matter of its field price from one of local to one of national significance, (a) by contributing to the postwar price increases and (b) by causing these price increases to affect people in all sections of the country.

Table I-5 shows the areas and states of destination of gas shipped outside the five-state Southwest area for the years 1925, 1935, 1945, and 1955, together with the percentages of Southwest marketed production shipped outside the area (these figures are in the last row). Total interstate shipments from the Southwest in 1955 were six times greater than in 1945, compared with a little less than twice as much consumption within the five states. In 1925 there were practically no interstate shipments. Note that only 2.7 per cent of total Southwest marketed production was sent outside the

TABLE I-5

AREAS AND STATES OF DESTINATION OF NATURAL GAS SHIPPED FROM FIVE SOUTHWEST PRODUCING STATES[1]—1925, 1935, 1945, AND 1955

(Volumes in Million Cubic Feet)

Destination	1925		1935		1945		1955[a]	
	Volume Received	Per Cent of Total	Volume Received	Per Cent of Total	Volume Received	Per Cent of Total	Volume Received	Per Cent of
New England								
Connecticut							13,796	
Massachusetts							42,093	
New Hampshire							1,239	
Rhode Island							5,115	
Area Total							62,243	
Mid-Atlantic								
New Jersey							76,255	
New York							202,325	
Pennsylvania					13,844	2.0	325,986	
Area Total					13,844	2.0	604,566	1
South Atlantic								
Delaware							4,525	
District of Columbia							8,986	
Florida					7,320	1.0	20,860	
Georgia			8,004	3.5	35,915	5.1	92,794	
Maryland					172	x	24,259	
North Carolina							13,834	
South Carolina							18,742	
Virginia					248	x	25,691	
West Virginia					22,591	3.2	109,668	
Area Total			8,004	3.5	66,246	9.4	319,359	
East North Central								
Illinois			55,567	24.5	104,737	14.8	413,636	1
Indiana			12,753	5.6	38,534	5.4	137,925	
Michigan					37,720	5.3	199,399	
Ohio					51,811	7.3	378,484	
Wisconsin							44,449	
Area Total			68,320	30.1	232,802	32.9	1,173,893	2
West North Central								
Iowa			19,077	8.4	27,794	3.9	135,726	
Minnesota			10,579	4.7	35,930	5.1	118,170	
Missouri	5,338	35.4	32,682	14.4	71,969	10.2	208,344	
Nebraska			13,635	6.0	26,652	3.8	81,408	
North Dakota							5	
South Dakota			1,554	0.7	4,076	0.6	9,319	
Area Total	5,338	35.4	77,527	34.2	166,421	23.5	552,967	1
South East								
Alabama			9,996	4.4	43,385	6.1	111,381	
Arkansas	9,665	64.2	20,309	9.0	45,431	6.4	176,378	
Kentucky					6,093	0.9	101,663	
Mississippi			3,430	1.5	33,747	4.8	106,692[b]	
Tennessee			9,479	4.2	24,388	3.4	120,789	
Area Total	9,665	64.2	43,214	19.1	153,044	21.6	616,903	1
Rocky Mountain								
Arizona			5,603	2.5	22,488	3.2	89,933	
Colorado			16,908	7.5	33,875	4.8	120,869	
Montana							28	
Nevada							2,470	
Wyoming			399	0.2	979	0.1	2,920	
Area Total			22,910	10.1	57,342	8.1	216,220	
Far West								
California							502,120	1

TABLE I-5 *Continued*

Destination	1925		1935		1945		1955[a]	
	Volume Received	Per Cent of Total	Volume Received	Per Cent of Total	Volume Received	Per Cent of Total	Volume Received	Per Cent of Total
U.S.	15,003	99.6	219,975	97.0	689,699	97.5	4,048,271	99.3
ign								
nada							11,198	0.3
exico	64	0.4	6,727	3.0	18,016	2.5	18,029	0.4
Total Foreign	64	0.4	6,727	3.0	18,016		29,227	0.7
d Total Five-State								
ipments	15,067	100.0	226,702	100.0	707,715	100.0	4,077,498	100.0
State Marketed								
oduction	563,694	100.0	1,251,185	100.0	2,862,702		8,037,551	
Cent of Production								
ipped	2.7		18.1		24.7		49.8	

otes: 1—Texas, Louisiana, Oklahoma, Kansas, and New Mexico. Excludes shipments among these states.
–Includes 846 million cubic feet (0.01 per cent of total) originating in Arkansas and N. Dakota.
–Most shipments to Mississippi are in effect re-exported, since shipments from that state (see Table II-2) are 24,000 million cubic feet greater than shipments into the state.
–Less than 0.05 per cent.
urce: Computed from Bureau of Mines data on interstate shipments and from annual reports to the Federal er Commission by El Paso Natural Gas Company and Southern Union Gas Company and other pipe lines ng the Rocky Mountain states.

area in 1925 and that this went only to two contiguous states, Missouri and Arkansas. By the middle 1930's more interstate activity had developed, especially to Illinois with the completion in 1931 of the first major long distance interstate pipe line (Natural Gas Pipeline Company). Even so, only 18 per cent of total marketed production was sent outside the area in 1935. By the end of World War II, one important long-distance line to the East (Tennessee Gas Transmission) was in operation, and one-fourth of the Southwest marketed production was being shipped outside the area. After the war, the number of interstate systems grew quite rapidly (see Table I-6) and the older systems expanded their capacities; by 1955 half of Southwest marketed production was being exported to other states. Note particularly how many other states. By 1955 Southwest gas was reaching all areas of the country except the Pacific Northwest, and shipments to this area through Pacific Northwest Pipeline Com-

TABLE I-6

APPROXIMATE CAPACITIES OF MAJOR LONG-DISTANCE INTERSTATE GAS TRANSMISSION LINES SERVING THE SOUTHWEST[1]
1946 AND 1955

Company	Capacity	
	1946	1955
	(MM c.f. per Day)	
Tennessee Gas Transmission	263	1,999
El Paso Natural Gas	79	1,993
Texas Eastern	—	1,279
Northern Natural	288	1,260
Texas Gas Transmission	—	1,120
Natural Gas Pipeline[2]	268	523
Texas Illinois[2]	—	504
Total Peoples Gas	268	1,027
Southern Natural	202	1,020
Panhandle Eastern and Trunkline[3]	347	890
Transcontinental	—	795
Colorado Interstate	139	627
Mississippi River Fuel	133	450
Pacific North-West[4]	—	377
Gulf Interstate	—	375
Coastal-Houston Texas Gas[4]	—	370
Michigan Wisconsin	—	303
American Louisiana	—	300
Total	1,719	14,185

Notes: 1—Excluding lines serving only producing and contiguous states (e.g., Arkansas, Louisiana, Cities Service Gas, Olin, etc.). United Gas Pipeline has some sales in Florida. Its capacities for 1946 and 1955 were 508 and 4,181 thousand M c.f./day respectively.

2 — Subsidiary of Peoples Gas Light and Coke Co.

3 — Subsidiary of Panhandle Eastern. Trunkline did not exist in 1946; its delivery capacity to Panhandle was about 265 thousand M c.f. per day in 1955.

4 — Not in operation in 1955.

Source: 1946 from *Smith-Wimberly Report on the Natural Gas Investigation* (April, 1948) p. 244.
1955 from F.P.C. *35th Annual Report, 1955*, p. 22, except Coastal from F.P.C. Press Release, June 21, 1956.

pany have since begun. Hence even such distant areas as Canada, Washington state, and New England are now being served by Southwest gas. The most important single receiving area in 1955 was the East North Central group of states (Illinois, Indiana, Michigan, Ohio, and Wisconsin), which was taking 29 per cent of total outside shipments.

After World War II, then, there was a marked increase in consumption of natural gas in the traditional primary market, the Southwest; but even more important was the growth of distant markets tapped by a newly developed system of interstate transmission lines. As has been pointed out, this change in the geographical structure of the final market for gas has resulted in an over-all change in the nature of that market.

C. End Uses of Natural Gas

Although it is probably not generally recognized, it must be understood that natural gas is primarily used in the United States for industrial purposes. The proportion of gas so consumed is steadily falling (this is the change in the nature of the market referred to above); but as of 1955 about 70 per cent of total consumption was still in the industrial category. Less than one-fourth was for home heating; the remainder was used for "commercial" purposes, principally heating of apartments, hotels, etc.

Relative shares of total consumption accounted for by residential, commercial and several important classes of industrial customers are shown for the period 1920-1955 in Table I-7. Note that the share of total consumption attributable to residential and commercial heating fell abruptly between

1920 and 1925 from 36 per cent to 23 per cent of the market. The volume of residential and commercial consumption actually declined somewhat in the face of about a 50 per cent increase in total consumption. The relative decline con-

TABLE I-7

CONSUMPTION OF NATURAL GAS IN THE UNITED STATES BY USES—1920–1955[1]
(Volumes in Billion Cubic Feet)

	1920	1925	1930	1935	1940	1945	1950	1955
Residential								
Volume	a	a	295.7	313.5	443.6	607.4	1198.4	2124.0
Per Cent of U. S.			15.2	16.4	16.7	15.6	19.9	23.4
Commercial								
Volume	a	a	80.7	100.2	134.6	230.1	387.8	629.2
Per Cent of U. S.			4.2	5.2	5.1	5.9	6.4	6.9
Residential and Commercial								
Volume	286.0	272.1	376.4	413.7	578.2	837.5	1586.2	2753.2
Per Cent of U. S.	35.8	22.9	19.4	21.7	21.8	21.5	26.3	30.4
Oil Field								
Volume	202.0	423.5	723.2	580.4	711.9	917.0	1187.5	1507.8
Per Cent of U. S.	25.3	35.6	37.2	30.4	26.8	23.5	19.7	16.7
Carbon Black								
Volume	40.6	140.4	266.6	241.6	368.8	431.8	410.9	244.8
Per Cent of U. S.	5.1	11.8	13.7	12.6	13.9	11.0	6.8	2.7
Refineries								
Volume	b	87.8	98.8	80.2	128.0	338.5	455.1	625.2
Per Cent of U. S.		7.4	5.1	4.2	4.8	8.7	7.6	6.9
Electric Utilities								
Volume	25.0	46.5	120.3	125.2	183.2	326.2	628.9	1153.3
Per Cent of U. S.	3.1	3.9	6.2	6.6	6.9	8.4	10.4	12.7
Other Industrial								
Volume	244.6	218.1	356.3	468.8	684.5	1049.5	1757.8	2786.0
Per Cent of U. S.	30.6	18.4	18.4	24.5	25.8	26.9	29.2	30.7
Total Industrial								
Volume	512.2	916.3	1565.2	1496.2	2076.4	3063.0	4440.2	6317.1
Per Cent of U. S.	64.2	77.1	80.6	78.3	78.2	78.5	73.7	69.6
Total								
Volume	798.2	1188.4	1941.6	1909.9	2654.6	3900.5	6026.4	9070.3
Per Cent of U. S.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: 1—Quinquennial data.
a—Not available separately before 1930.
b—Included in "Other Industrial."
Source: Consumption from Bureau of Mines.

tinued somewhat farther for the next five years; but after an upswing in the early 1930's, which is attributable to the decline of industrial production in the depths of the depression, residential and commercial consumption together accounted for about 22 per cent of total through World War II.

Thereafter the percentage began to rise, reaching 30 per cent in 1955. In absolute terms, residential and commercial consumption in 1955 was over three times the 1945 level; this is a more rapid rate of increase than that of any important industrial category except electric power utilities. It should also be observed from Table I-7 that in one industrial category, viz., the production of carbon black from natural gas, consumption has actually fallen in absolute terms since the end of World War II. Whereas, carbon black production once accounted for almost 14 per cent of the market, its share has now fallen below 3 per cent; and the absolute level of such consumption is roughly half the amount consumed in 1945.

There are two primary reasons for this shift in total United States consumption away from industrial use toward residential use: (1) the change in location of consumption and (2) the postwar increase in price. Most important in explaining the change in residential and commercial consumption relative to total industrial consumption (ignoring for the moment the kind of industrial consumption), is the change in the geographical structure of the market. This is perhaps best demonstrated by comparing the relative importance of various uses of gas in the Southwest with areas more distant from the fields. Table I-8 compares combined consumption of gas for residential and commercial purposes with industrial consumption for the five major Southwest producing states and for three Appalachian states. The last states were chosen because they are now important consuming centers distant from markets, as well as once having been important producers. (West Virginia, as was pointed out above, still produces somewhat more than it consumes.) This table shows that industrial use in the Southwest is much more important

relative to total consumption than in the East. Since the mid-1920's, when production began to develop in earnest in the Southwest, industrial consumption has accounted for about *90* per cent of total consumption in this area. Since World War II there has been a modest decline in the share of total

TABLE I-8

CONSUMPTION OF GAS FOR VARIOUS PURPOSES IN LEADING PRODUCING STATES 1920–1955[1]

Year	Resid. & Commercial		Industrial		Total	
	Volume (MM c.f.)	Per Cent of Total	Volume (MM c.f.)	Per Cent of Total	Volume (MM c.f.)	Per Cent of Total
I *Southwest*[2]						
1920	47,816	18.7	207,699	81.3	255,515	100.0
1925	46,637	8.5	501,990	91.5	548,627	100.0
1930	95,586	8.6	1,015,091	91.4	1,110,677	100.0
1935	96,663	9.4	930,791	90.6	1,027,454	100.0
1940	136,486	9.6	1,290,673	90.4	1,427,159	100.0
1945	192,860	8.9	1,962,960	91.1	2,155,820	100.0
1950	290,886	9.8	2,686,072	90.2	2,976,958	100.0
1955	411,318	10.6	3,457,908	89.4	3,869,226	100.0
II *Appalachian*[3]						
1920	184,051	46.2	214,507	53.8	398,558	100.0
1925	163,503	53.5	142,191	46.5	305,694	100.0
1930	166,677	56.1	130,239	43.9	296,916	100.0
1935	126,479	50.3	124,781	49.6	251,260	100.0
1940	154,892	47.1	173,734	52.9	328,626	100.0
1945	189,352	46.2	220,755	53.8	410,107	100.0
1950	389,748	54.1	330,318	45.9	720,006	100.0
1955	595,967	56.8	453,184	43.2	1,049,151	100.0

Notes: 1—Quinquennial data.
2—Texas, Louisiana, Oklahoma, Kansas, New Mexico
3—West Virginia, Pennsylvania, and Ohio
Source: Consumption from Bureau of Mines.

Southwest consumption attributable to industrial use (from 91.1 per cent in 1945 to 89.4 per cent in 1955); but in the Southwest, gas is *the* fuel, industrial and residential. Of course, total industrial fuel consumption would be expected to be relatively more important in the Southwest because

the milder winter climate and lower heating requirements for homes and because of higher usage in drilling. But more important is the fact that in the Southwest, many miles distant from coal production, gas commands a competitive price premium over that important Eastern industrial fuel.

In the Southwest, gas consumption is clearly predominantly for industrial use. On the other hand, in the three Eastern states industrial consumption has represented only 43 to 54 per cent of total consumption over the past 35 years. This was even true when the Appalachian region was an important producing area. For the three states in Table I-8, there is a relative downward trend in industrial use since World War II, with 57 per cent of total consumption in that area attributable to residential and commercial use in 1955. In some other important consuming states, e.g., Illinois, there is a higher proportion of industrial consumption than of residential and commercial (61 vs. 39 per cent in 1955); but in general, residential and commercial consumption is much more important in the East than in the Southwest. Even in California, where the climate is warmer than in the East and where there is active drilling and considerable field use of gas, residential and commercial consumption amounted to about 37 per cent of total in 1955.

While industrial consumption is still about 90 per cent of total in the Southwest, there has been a considerable change even in these states in the types of industrial use. This is shown in Table I-9, using Texas as an example. This table indicates the proportions of total industrial consumption attributable to field use (for drilling, pumping, etc.), carbon black manufacture, refinery fuel, electric power generation, and other general industrial use. As was pointed out earlier, carbon black production, which once took 40 per cent of

TABLE I-9

INDUSTRIAL USE OF GAS IN TEXAS—1920–1955

(Volumes in Billion Cubic Feet)

Year	Field		Carbon Black		Refinery		Electric Power		Other Industrial		Total Industrial	
	Vol.	Per Cent of Total	Vol.	Per Cent of Total	Vol.	Per Cent of Total	Vol.	Per Cent of Total	Vol.	Per Cent of Total	Vol.	Per Cent of Total
1920	30.6	77.3	—	—	[a]	—	1.4	3.5	7.6	19.2[b]	39.6	100.0
1925	61.8	48.5	16.9	13.3	[a]	—	[a]	—	48.6	38.2[b]	127.3	100.0
1930	163.5	33.7	176.4	36.4	25.8	5.3	43.9	9.0	75.5	15.6	485.1	100.0
1935	199.9	41.1	180.5	37.1	25.5	5.2	31.3	6.4	49.6	10.2	486.8	100.0
1940	310.4	37.9	330.7	40.3	66.4	8.1	51.3	6.3	60.7	7.4	819.5	100.0
1945	453.2	35.7	371.7	29.2	167.0	13.1	104.1	8.2	175.3	13.8	1271.3	100.0
1950	601.3	35.3	313.0	18.3	243.2	14.3	165.4	9.7	382.4	22.4	1705.3	100.0
1955	772.3	37.5	154.6	7.5	328.7	16.0	273.3	13.3	530.0	25.7	2058.9	100.0

Notes: a—Included in "other industrial"; not available separately.

b—Percentages not precisely comparable with later years, since some refinery use is included in 1920 and refinery and electric power use are included in 1925.

Source: Bureau of Mines.

industrial consumption in Texas, now takes a much smaller total volume (and of course a smaller share of total in an increasing market). The reason for this is that increased prices have diverted gas to other uses, primarily general industrial use and as a boiler fuel for electric power generation, where the resource is used as a fuel instead of as a raw material for the production of carbon. In addition to industrial heating and the generation of electric power for general use, gas is used in Texas today for refinery fuel, chemical plant fuel, generation of electric power for aluminum production, and as a raw material for petro-chemical production. All of these industries utilize gas for more productive ends than the burning off of the hydrogen to get a carbon residue; hence all are able to pay a higher price, and carbon black has been largely priced out of the market. Likewise, field use is not so important relatively as it was in the 1920's, but apparently field use has begun to grow somewhat once more relative to total after a decline through the war years and much of the postwar period.

It may be concluded that even though the consumption of natural gas is still primarily for industrial purposes in the country as a whole (and especially in the Southwest), the changing geographical pattern of the market will lead to an ever-increasing share of total consumption for residential and commercial heating. Even in the Southwest, in the absence of a sharp decline in price, gas will continue to be used more and more as a general industrial fuel or as a raw material for highly valuable petro-chemicals, and not as the raw material for carbon black production. It might be noted in passing that liquefied petroleum gases (ethanes, butanes, propanes, etc.), which are not now readily transportable over long distances as is dry natural gas (methane), sell for a

lower price than gas in the field and have therefore become the primary raw material for carbon black production. Should dry gas prices be driven down appreciably by bonanza discoveries or by regulation, the production of carbon black might once more begin to utilize large quantities of methane. Should prices continue to rise, gas might even be driven out of use as a boiler fuel in the Southwest in favor of fuel oil.

D. Prices

Field prices of natural gas in the United States averaged about 10-11 cents per thousand cubic feet (M c.f.) in the early 1920's. In the last half of the 1920's, average prices fell somewhat with the beginning of flush production in the Southwest and reached the 8-cent level in 1930 (see Table I-10). Under the impetus of decreased demand, prices fell steadily over the next five years. Demand began to increase in the latter part of the 1930's, but more large discoveries kept prices around five cents until 1947. The lowest annual average was 4.5 cents in 1940.

In Texas, as an example of the Southwest, average prices fell more rapidly in the 1920's and reached the 2-cent level in 1931. The minimum average price was 1.8 cents in 1940, and the average remained around two cents until 1946. Average prices in Texas did not exceed five cents until 1952.

These Bureau of Mines average prices indicate directions of movements; but they will not do as measures of absolute price levels for new gas sales, except possibly in the 1920's and early 1930's. Since the late 1920's, more and more gas has been sold under long-term contracts of 20 years and longer. Average prices for all gas sales in any given year will, therefore, reflect transactions conducted at various times in the past, perhaps as much as a quarter-century in

the past. The proper measure of prices in a given year is an average of prices on new contracts. If such current spot prices remained constant over long periods, the inclusion in

Table I-10

Average Well-Head Prices of Gas in Texas and in the United States as a Whole—1925–1955

Texas		Total U. S.	
Year	Price (¢ Per M c.f.)	Year	Price (¢ Per M c.f.)
1925	5.2	1925	9.4
1926	5.7	1926	9.5
1927	4.4	1927	8.8
1928	3.4	1928	8.9
1929	3.3	1929	8.2
1930	3.6	1930	7.6
1931	2.2	1931	7.0
1932	2.2	1932	6.4
1933	2.4	1933	6.2
1934	2.2	1934	6.0
1935	2.1	1935	5.8
1936	2.3	1936	5.5
1937	2.3	1937	5.1
1938	2.2	1938	4.9
1939	2.1	1939	4.9
1940	1.8	1940	4.5
1941	2.0	1941	4.9
1942	2.2	1942	5.1
1943	2.4	1943	5.2
1944	2.5	1944	5.1
1945	2.6	1945	4.9
1946	3.0	1946	5.3
1947	3.7	1947	6.0
1948	4.5	1948	6.5
1949	4.6	1949	6.3
1950	4.7	1950	6.5
1951	5.4	1951	7.3
1952	6.2	1952	7.8
1953	7.6	1953	9.2
1954	8.5	1954	10.1
1955	8.0	1955	10.4

Source: U. S. Bureau of Mines, *Minerals Yearbook.*

the average of sales from earlier years would not matter; however, spot prices in this market have risen since the war. The earlier, low-priced sales depress over-all postwar averages; hence some other measure is required for this period.

Likewise, an accurate appraisal of the spot market in the late 1930's is somewhat obscured by the use of the overall average because the 2.3 cent prices around 1930 tended to keep the average *up*. The Texas spot price in 1940 must have been very low, indeed, to pull the average down to 1.8 cents, but the absolute error in the late 1930's cannot be very great, since the average price was so near zero.

In order to describe prices on new sales since the war, it is necessary to use other data from unpublished sources. A survey of interstate contracts financed by a group of producers and sponsored jointly by these producers and the Federal Power Commission staff has provided the basic data for postwar time series on spot prices.

Tables I-11 and I-12 show 1956 volumes of postwar long-term sales to interstate buyers distributed by date of contract and price for two important gas-producing areas. The areas are the lower Texas Gulf Coast (Railroad Commission District 4) and the Louisiana Gulf Coast (South Louisiana). The Louisiana tabulation begins in 1948 because there are no 1946 and 1947 long-term contracts now in force there. Both tabulations have been limited to long-term contracts for 15 years or more, with the most common length being 20 years. Prices on 10-year and 20-year contracts are not comparable, and the more common long-term transactions were chosen for illustrative purposes.

The prices quoted in Tables I-11 and I-12 are specified "life-of-contract" averages. Commonly, prices are not specified at a flat rate over the 20-year period. Rather there is a

schedule providing for escalation of the initial price in specified amounts at specified time periods. A common average specified step-up of the initial price is 0.2 cents per year (or one cent every five years). Such a schedule represents not so much varying prices as varying plans of payment, and it is the average expected revenue over the life of the contract which is the true price at which the contract is negotiated. Thus, if a 20-year price schedule starts at 16 cents and escalates one cent every five years, the life-of-contract average used in the tabulation would be 17.5 cents. This averaging assumes equal deliveries over time. Constant flow is not a certainty, since a well might not live up to expectations. Prediction of reserves is a tenuous matter; and a well might become dry before producing 20 years, even though it was believed capable of such production initially. However, more or less level production for the life of the contract would normally be expected, since the pipe line which buys the gas must be operated at a more or less constant throughput in order to minimize transport costs.

If all contracts had the same type of specified escalations, say, one cent every five years, it would not be necessary to compute the life-of-contract average in order to *compare* prices. However, the schedules are not the same, and some contracts are on a flat-rate basis. There are very real differences between a contract escalating from 16-20 cents, a contract at a flat 16 cents, and a contract escalating from 16-18 cents. Use of the initial prices in each case to compare these contracts would show them to be the same. It is, therefore, necessary to average even for comparative purposes; and this is certainly necessary in evaluating the absolute level of prices.

A desirable refinement of the average just discussed would

involve discounting the varying time spreads of payments to present values. A flat 17.5-cent contract is somewhat more valuable to the producer than a 16-19 cent step-up because more revenue is received in the earlier years. (The additional money received in the early years can be put out at interest or otherwise reinvested.) Test computations have shown that the difference in present value between 17.5 cents flat and

TABLE I-11

DISTRIBUTION OF LONG-TERM INTERSTATE CONTRACTS BY PRICE RANGES, SOUTH LOUISIANA—1948–1955

Specified Life-of-Contract Price Range (¢ per M c.f.)	1956 Volumes of Sales at 15.025 p.s.i. (MM c.f.)							
	1948	1949	1950	1951	1952	1953	1954	1955[a]
9 to 10	34,331		293	1,922	214	151	293	
10 to 11		16,396	97,953	75,151	2,645	1,886	411	212
11 to 12						4,363		1,352
12 to 13								
13 to 14					788			
14 to 15				21,986				
15 to 16								
16 to 17					23,556			
17 to 18						32,068	17,037	20,667
18 to 19					41,058	36,454	2,639	16,827
19 to 20					40,483			
20 to 21								25,995
21 to 22					18,241	2,523	25,790	16
22 to 23						8,111		
23 to 24						30,666		17,557
Total	34,331	16,396	98,246	99,059	126,985	116,222	46,175	82,626
Weighted Average Price	9.4¢	10.1¢	10.4¢	11.3¢	18.7¢	19.6¢	19.5¢	19.6¢

Note: a—Includes a small amount of estimated volumes for contracts under which deliveries did not begin until late in 1956. Estimate is from contracts filed with the F.P.C.
Source: Prices computed from contracts filed with the F.P.C. Volumes from 1956 pipe line annual reports to the F.P.C. (F.P.C. Form 2).

16-19 cents escalated over 20 years is not great. Hence we shall not refine the data in Tables I-11 and I-12 to this extent.

There is one instance where at least qualitative recognition of the present value problem is important. This occurs when a prospective pipe line signs contracts for gas with delivery not scheduled to begin for two or three years. Such contracts are clearly less valuable than would be contracts

at the same price with immediate delivery. The prices between 23 and 24 cents in South Louisiana in 1953 are in this category, since they are from contracts on which deliveries did not begin until 1956. Likewise the small volume shown between 16 and 17 cents in District 4 in 1955 is an estimate of annual deliveries under contracts which were signed in December, 1955, but under which there were no deliveries until 1957.

TABLE I-12
DISTRIBUTION OF LONG-TERM INTERSTATE CONTRACTS BY PRICE RANGES, TEXAS RAILROAD COMMISSION DISTRICT 4—1946–1955

ecified Contract Range r M c.f.)	1956 Volumes of Sales at 14.65 p.s.i. (MM c.f.)									
	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955[a]
to 5			8,020							
to 6	6,703			1,293						
to 7		45,997	16,482	31,954	10,758	1,199				
to 8					23,157	14,027				
to 9				1,346	22,475	927	5,446	93		
to 10					23,480					
to 11							177			
to 12							85,782	24,856	8,005	
to 13						14,393			20,157	16,520
to 14							3,428		51,686	29,678
to 15							8,685	19,527	10,859	
to 16										
to 17										1,023
Total ed	6,703	45,997	24,502	34,593	79,870	30,546	103,468	43,976	90,707	47,221
age Price	5.7¢	6.4¢	5.8¢	6.7¢	8.1¢	9.7¢	11.3¢	12.6¢	13.3¢	13.4¢

: a—Includes a small amount of estimated volumes for contracts under which deliveries did not begin until late . Estimate is from contracts filed with F.P.C.
ce: Prices computed from contracts filed with the F.P.C. Volumes from 1956 pipe line annual reports to the (F.P.C. Form 2).

In addition to the specified price schedule, there are indefinite pricing provisions in most postwar contracts. These cannot be quantified readily; and they are, therefore, necessarily ignored in Tables I-11 and I-12. Since the basic purpose of these clauses is to guard against future changes in the spot market price after a long-term contract is signed, they should probably not be reflected in these tabulations of spot prices, even if quantification were possible. The eco-

nomic significance of the indefinite pricing clauses will be discussed in Chapter III.

What do the price tabulations for District 4 and South Louisiana show? In both areas prices were rather stable through 1950. Late in 1951 and in 1952, sharply higher prices appeared. And the average price level of 1953-1955 was rather stable at approximately twice the level that existed before 1951. This change in field prices is summarized in the following table:

AVERAGE LIFE-OF-CONTRACT PRICES FOR LONG-TERM INTERSTATE SALES IN DISTRICT 4 AND SOUTH LOUISIANA[1]—1946–1955

Year	District 4 —Cents per M c.f. at 14.65 p.s.i.—	South Louisiana[2] —Cents per M c.f. at 14.65 p.s.i.—
1946	5.7	N.A.
1947	6.4	N.A.
1948	5.8	9.2
1949	6.7	9.8
1950	8.1	10.1
1951	9.7	11.1
1952	11.3	18.2
1953	12.6	19.1
1954	13.3	19.0
1955	13.4	19.1
1946–50 Average	7.1	9.9
1953–55 Average	13.2	19.1

Notes: 1. Weighted by 1956 volumes
2. Prices in Table I-12 are at the Louisiana standard pressure base of 15.075 p.s.i.; these are converted to the Texas standard of 14.65 p.s.i. in this table for comparability with District 4 prices.
Source: Tables I-11 and I-12

Before the price rise of 1951-1952, District 4 prices averaged 7.1 cents; after 1952 they averaged 13.1 cents, an increase of 86 per cent. Similarly average South Louisiana prices rose from 9.9 to 19.1 cents (at 14.65 p.s.i.), an increase of 93 per cent. The difference between the prices in the two areas

reflects primarily the additional 500 or so miles of pipe required to reach the lower Texas Coast from the north.

The sharp increase in field prices over the space of a year or so is undoubtedly responsible for much of the political support of price regulation for the industry. Such a rapid rise in prices is, of course, quite possibly compatible with the operation of a competitive market where consumption increases rapidly and where a good part of the increase is in higher value uses, as has been shown to be the case in this industry. Total marketed production averaged 5.1 trillion cubic feet per year for the country as a whole in the period 1946-1950, compared with 8.8 trillion from 1953-1955, an increase of about 75 per cent, compared with the 86 and 93 per cent increases in price in the two areas discussed. The relative price increases are not appreciably greater than the relative increases in consumption for the nation as a whole; and in these two areas marketed production was probably up more than the national total.

Nonetheless, the very rapidity of the increase in price has doubtless led to a suspicion of monopoly pricing. It is now in order that we appraise the structure of the industry as the first, and most important, step in determining whether monopoly pricing has, in fact, occurred since 1951.

CHAPTER II

STRUCTURE OF THE FIELD MARKET FOR NATURAL GAS

IT HAS been pointed out that the *sine qua non* of competition on the selling side of a market is that there be a number of real alternative sources of supply available to buyers. The question at hand is the extent of these alternatives in the field market for natural gas. In describing market structures there are usually (at least) three fundamental issues present: (1) what products should be considered to be part of the market, sometimes described as the problem of "inter-product competition;" (2) what is the proper measure of relative size of firms; and (3) what is the appropriate geographical market area. In the gas market there is also a unique fourth problem concerning long-term contracts. It is necessary that these problems be discussed before proceeding to an examination of the market structure. After this discussion the order of procedure will be to analyze: shares of total current sales held by the larger sellers; shares of current sales made under recent contracts; changes in shares of sales over time; expected future market structure; and, in summary, the competitive significance of the market structure in this industry.

(1) *Inter-product Competition*—Here we shall limit ourselves to a consideration of natural gas alone, although gas, coal, and fuel oil are at least as competitive as are cellophane and aluminum foil, which have been held to be legal competitors.[14] In so limiting the inquiry, it must always be remembered that the existence of competitive fuels constitutes

further source of competition for gas producers. Oil is perhaps less important than is coal in assessing alternative sources of fuel supply because most gas is produced by companies which also produce oil and hence compete with themselves in a sense. But many coal mines are, in a very real sense, competitors of gas producers in a substantial part of the gas market. In evaluating the competitiveness of other industries, the existence of such a force in the "market" (broadly defined) might well be of critical importance to the inquiry, as it was to Du Pont in the cellophane case. However, here it will be sufficient to say, qualitatively, that the existence of coal mines makes gas more competitive than would appear to be the case from examining only the gas producers; in other words, our computations will understate competitiveness. As will be seen, quantification of this proposition will not be necessary.

(2) *Measurement of Relative Size*—Insofar as the proper measure of the size of firms is concerned, it is, of course, not sufficient simply to count the firms. One very large firm and many small firms make for entirely different competitive conditions from those that would exist with the same number of small firms. It is the number and *relative* size of firms which is important. This is usually measured by "concentration ratios," i.e., by the percentage of the industry accounted for by, say, the top four, or eight, or twenty firms—usually the top four. Such a measure is defective in that it tells us nothing about the relative sizes of firms *within* the first four. An industry where the largest firm has 45 per cent of the market and the next three have one per cent each, has a concentration ratio of 48 (based on the top four); so does an industry where the top four firms each have 12 per cent, but competitive conditions in the two will doubtless be very different

indeed. By this measure, two market structures which are actually quite different appear to be the same.

What is needed is a measure of relative size all along the line from largest to smallest. A device for this purpose is the "concentration curve," which shows cumulative shares of the market held by the firms ranked by size. By this measure, in the first example above the top firm has 45 per cent, the two top firms together have 46 per cent, three have 47 per cent, four have 48 per cent. On the other hand, this measure applied to the second example would show 12 per cent for one, 24 for two, 36 for three, and 48 for four. Hence two industrial structures which are actually very different are shown to be different by this system of measurement of "concentration." In this study we shall use as a measure of industrial concentration the shares of the market held individually and cumulatively by the top 20 companies.

Another question associated with the proper measure of relative size of firms is the *type* of measure. Should relative size be measured by value added, by dollar sales volume, by physical sales volume, by capacity, by the number of employees, by assets, etc.? This is often a question of some controversy.[15] However, it is this writer's opinion that in a situation where products are homogeneous and easily measurable in physical terms, either physical productive capacity or physical output is the most acceptable measure of the alternatives available to buyers. Where products are not so homogeneous, dollar sales volume may be preferable (a case might be made for counting Fords and Cadillacs by value instead of by numbers of cars). Of the two physical measures, capacity is preferable if there is no great problem of obsolete facilities, which might distort relative sizes if some firms have more of such capacity than do others. It is, after

all, relative capacities to produce which are most important to the prospective customer when he is evaluating the true extent of his potential alternative sources of supply. Whether company A has 50 per cent of employees, or 40 per cent of assets measured by book costs incurred over thirty years, is really of little consequence to the buyer except indirectly as these data may reflect A's ability to produce; what really matters is how much A can deliver relative to B and C.

Unfortunately, in the gas producing industry, capacity data are of limited availability. Because of their necessarily speculative nature such data would be of limited usefulness even if they were widely published. Hence we shall be forced to rely primarily on volumes of sales of gas. The tabulations of sales will measure what actually happened, not necessarily what *could* have happened, as would tabulations of concentration of capacities. Some evaluation of what could have happened and what can be expected to happen in the future will also be possible.

Since a cubic foot of gas of certain quality specifications is a cubic foot of gas, regardless of who brought it out of the ground, gas is largely a homogeneous product when it is delivered to the pipe line. Hence the Ford-Cadillac product differentiation question does not exist. Valuation of sales is, therefore, unnecessary; and physical volumes will constitute an acceptable measure of concentration.

(3) *Geographical Extent of the Market*—The third issue mentioned above was that of the proper geographical extent of the market. In the instant case it is possible to make a rather good case for the existence today of a near-national market in gas production. Such is often not the case in many industries (and it was probably not the case in gas production before the widespread building of interstate transmis-

sion lines after World War II). For example, to the movie-goer in, say, Boston it is a matter of little direct concern whether there are 5 or 50 exhibitors in New Orleans. Here the relevant geographical market is Boston. To the gas pipe-line company planning a new line to serve Boston, if such were permitted under the law, the choice of fields where it can buy gas is widespread: from Mexico to Canada, north and south; from the Four Corners to Mississippi, east and west. There is even some gas available in California and the Appalachian fields, but only in amounts which are small relative to local consumption; there are no interstate sales from California fields.

On the other hand, an existing pipe line system which wishes to sell more gas may find it cheaper to expand the capacity of an existing line than to lay a new one. In this event, it must get the supplies from the area along the line. Hence there are some instances where the relevant market is a given producing area. This situation has led to the fatuous "garden hose" argument that there is no competition in the gas fields because a pipe line is not movable like a garden hose; it is tied to the sellers in its area. This proposition is doubly defective in that, first, it ignores the fact that the bulk of supplies for a line are contracted on a 20-year basis *prior* to construction; otherwise neither financing nor a certificate of public convenience and necessity could be had. As has been noted, before construction the line may be planned to go almost anywhere in the Mid-Continent producing area. Second, the argument assumes implicitly that further supplies bought after the line is laid are bought under monopolistic conditions; this is only true if (1) there are a very few sellers along the line or (2) there is collusion among many sellers. Furthermore, there are today three large sys-

tems which have lines in *two* primary producing areas (Panhandle-Hugoton and the Gulf Coast), with others in process. Such lines are not even dependent on one area for small expansions of existing lines.

Nonetheless, in some instances a pipe line will be dependent upon the producing area it serves for gas. This is particularly true for small expansions, which represent a minor part of purchasing; for large expansions, any line can always build a new branch to territory heretofore untapped by it if it finds gas prices there sufficiently low to offset any extra capital outlays required for the new line.

Hence the true geographical market lies somewhere between total nation-wide production and area production, with the nation—at least that part where interstate sales are made—being closer to actuality for large-scale buying by the interstate carriers. In order to deal with this problem, we shall evaluate the market, where possible, on a dual basis: (1) all areas of the country where interstate sales occur, omitting California and covering primarily the five states discussed in Chapter I; and (2) the Gulf Coast, as an important example of the situation existing in a more limited supply area.

Consideration of all such sub-areas as the Gulf Coast is not feasible here because of the labor involved in computation. The Gulf Coast was chosen as the more limited area for study because it has been very important in recent years. Of all 1955 sales to interstate pipe lines under contracts dated 1951-1955, 45 per cent were made from the Gulf Coasts of Texas, Louisiana, and Mississippi. About 10 major interstate pipe line systems purchase gas along the Gulf Coast, while only a very few of the principal transmission lines have no direct connection with the area. For these reasons, the Gulf

Coast is an acceptable example of a sub-national producing area. The true picture of the market typically faced by the buyer of gas will, then, lie somewhere between the total interstate and Gulf Coast pictures to be drawn below.

(4) *Long-Term Contracts and Concentration*—Before proceeding, one problem in the measurement of industrial concentration which is peculiar to natural gas must be mentioned. In the usual industry where sales are made on a day-to-day or short-term contractual basis, market alternatives can be shown by shares of total sales (or capacity). However, in the market for natural gas a great many sales are made under 20-year contracts. Hence some sellers may have all their capacity committed for 20 years and thus actually not be alternatives available to new buyers, even though they appear in a tabulation of sellers in the market today. It is theoretically conceivable that a tabulation of the top 20 sellers in 1955 might not contain any sellers who actually had gas available for sale in that year, or who *had* had any for sale for many years. This problem is particularly important in evaluating the competitiveness of prices negotiated after 1951, when substantial increases began to occur. The fact that there were many sellers of gas at the time would not, in itself, necessarily prove that there were many sellers who had gas available in 1951. In short, there could from time to time conceivably be quasi-monopolistic results in an industry where sales are made on a long-term basis even though there are many sellers in total. The existence of free entry would in the long-run mitigate considerably the problem of having only a few sellers actually in the market from time to time; but the limited alternatives would be of real concern to any buyers who needed badly to buy at those times.

We shall deal with this question by considering, in addi-

tion to total sales, volumes of sales made in various time periods and by predicting the future structure of the industry on the basis of current exploratory activity, i.e., on the basis of current activity designed to develop new capacity. However, we shall begin by describing the over-all structure of the market without reference to date of contract.

A. Distribution of Total Sales to Interstate Buyers (Regardless of Contract Dates)

In evaluating the market structure on an over-all basis without consideration of the date of sales, we shall examine three primary measures of structure: (1) all sales to interstate buyers; (2) reserves; and (3) Gulf Coast sales to interstate buyers. In addition, one tabulation of sales to *all* buyers (including intrastate buyers) will be discussed.

(1) *Distribution of All Sales to Interstate Buyers*—Table II-1 shows the distribution of all sales to all interstate buyers in the United States in 1955 (as measured by 1955 volumes of sales). These buyers are principally interstate pipe lines, including subsidiaries of distributing utilities; but in some cases the sales are made directly to distributors who have the gas transported on a contract-carrier basis by a non-integrated pipe line. Table II-1, which will serve as a preliminary evaluation of the structure of the field market for natural gas, shows that the top four sellers held 23 per cent of total sales to interstate buyers in 1955; the top eight held 35 per cent; and the top twenty held 54 per cent. The largest seller had 8.74 per cent of total sales. Note also that there is a gradual decline in the size of sellers, with the first being half-again as large as the second, the second a fifth larger than the third, etc. Appraisal of the competitive significance of such an industrial structure will be made in detail later;

TABLE II-1

SHARES OF TOTAL SALES OF NATURAL GAS TO INTERSTATE BUYERS HELD BY THE TWENTY LARGEST SELLERS—AS MEASURED BY 1955 VOLUMES OF ALL CONTRACTS

Seller	1955 Volumes (M c.f. at 14.65 p.s.i.)	Per Cent of Total	Cumulative Per Cent of Total
1. Phillips	511,113,955	8.74	8.74
2. Standard (Indiana)	324,296,232	5.54	14.28
3. Humble	268,144,970	4.58	18.86
4. Union Producing	231,320,866	3.95	22.81
5. Cities Service	214,508,599	3.67	26.48
6. Shell	190,547,320	3.26	29,74
7. Magnolia	163,906,059	2.80	32.54
8. Chicago Corp.	150,237,142	2.57	35.11
9. Gulf	147,643,569	2.52	37.63
10. Texas Company	131,512,727	2.25	39.88
11. Atlantic	124,790,611	2.13	42.01
12. Shamrock	89,595,951	1.53	43.54
13. Pure	87,971,532	1.50	45.04
14. Sun	82,351,101	1.41	46.45
15. Ohio	78,834,690	1.35	47.80
16. Tidewater	77,796,361	1.33	49.13
17. Sunray	72,341,319	1.24	50.37
18. Skelly	69,544,744	1.19	51.56
19. Southern Production	64,553,341	1.10	52.66
20. Superior	62,184,420	1.06	53.72
Total of 20	3,143,195,509	53.72	
All Others	2,707,714,263	46.28	
Grand Total	5,850,909,772	100.00	

Source: Computed from pipe line annual reports to the F.P.C. (F.P.C. Form 2).

but it may be said here that this is not by any means a high degree of concentration. Neither is there anything like a dominant firm which is much larger than any of its competitors.

Some discussion of the source and pitfalls of the data used in computing Table II-1 is in order, particularly since the same source will be used for a number of tables in this chapter. The data are derived from annual reports to the Federal

Power Commission by interstate buyers of gas (F.P.C. Form 2), not to be confused with annual reports to stockholders. The first point to be noted is that the data cover only sales to *inter*state buyers. As such they exclude sales to some intrastate customers, the data for which are available only on a fragmentary basis. However, Table II-1 does include intrastate sales which are made to pipe lines which also sell in interstate commerce—notably to United Gas, which has extensive distributing facilities in the producing areas. The sales in the table account for 5.85 trillion cubic feet, relative to a total marketed production in the United States excluding the Far West of 8.87 trillion, or 66 per cent of total. A third, then, of the total volume in the area giving rise to interstate sales is not covered by the table. However, the total volume subject to federal regulation is covered.

Furthermore, it should be pointed out that an expansion of the market covered in a study of concentration would probably, although not necessarily, lead to a decrease in the shares of the market held by any given number of leading sellers. Unless all firms operate in all areas, it is a mathematical certainty that increasing the size of the market studied will decrease concentration at some point in an array of cumulative percentages of the market because, say, 100 firms may have the total volume in the sub-area while, say, 200 have the total in the whole area. Since all gas producers do not operate in every supply area or in both interstate and intrastate commerce, it can be said with some confidence that the addition of more sales to a tabulation being studied would decrease the share of the total held by the larger firms as measured by the share of, say, the top 15 or 20 (or, conversely, that decreasing the total would increase the share of the top 15 or 20). However, this is not necessarily true for

TABLE II-2

SHARES OF SALABLE GAS PRODUCTION IN TEXAS HELD BY THE TWENTY LARGEST SELLERS—AS MEASURED BY DECEMBER, 1953 VOLUMES

Seller	December, 1953 Volumes (M.c.f. at 14.65 p.s.i.)	Per Cent of Total	Cumulative Per Cent of Total
1. Phillips	30,533,656	7.50	7.50
2. Humble	27,107,927	6.66	14.16
3. Standard (Indiana)	16,732,075	4.11	18.27
4. Sun	12,949,387	3.18	21.45
5. Union Producing	12,028,679	2.95	24.40
6. Colorado Interstate	11,760,210	2.89	27.29
7. Magnolia	11,705,540	2.87	30.16
8. Gulf	11,408,570	2.80	32.96
9. J. S. Abercrombie	10,373,678	2.55	35.51
10. Texas Company	8,966,551	2.20	37.71
11. Shell	8,663,098	2.13	39.84
12. Shamrock	7,926,056	1.95	41.79
13. Cities Service	7,921,626	1.95	43.74
14. Atlantic	7,287,603	1.79	45.53
15. Natural Gas Pipe Line Co.	6,630,735	1.63	47.16
16. Chicago Corp.	6,242,842	1.53	48.69
17. Skelly	5,721,121	1.41	50.10
18. Sunray	5,670,172	1.39	51.49
19. Tidewater	5,008,716	1.23	52.72
20. La Gloria	4,596,467	1.12	53.84
Total of 20	219,235,509	53.84	
All Others	187,954,730	46.16	
Total Texas	407,190,239	100.00	

Source: Computed from data tabulated from tax records of the Texas Comptroller by the C. S. Lockwood Co. at the request of Humble Oil & Refining Co.

the share of the market held by the top few firms, since it is conceivable that one seller might have all the additional volume which is added to the tabulation. It is conceivable, for example, that one seller might have nearly all the intrastate volume not covered by Table II-1, perhaps 30 per cent of total; in this event the true over-all market structure would

be very different indeed from that indicated by this table. We might possibly have a market with one firm having 30 per cent, while the next largest had only about 6 per cent.

Actually, this is not by any means the case. While we do not know the structure of the entire market for the whole Mid-Continent supply area, a good idea of this structure can be had from Table II-2, which shows shares of all sales held by the 20 largest sellers in Texas in December, 1953. These data are derived from tax records of the Texas Comptroller. These figures are not published regularly, but are available for examination. Since the tabulations are extremely laborious, we have used here one that happens to be available; the period does not coincide with that in Table II-1, but it will do for general comparative purposes. Table II-2, which covers a state that accounts for half of the total marketed production in the United States, indicates clearly that total sales are as widely distributed among sellers as are sales to interstate buyers. Note the close correspondence of shares of total interstate and total Texas sales held by various numbers of firms:

Share Held by Top	All U. S. Interstate Sales in 1955	All Texas Sales in December, 1953
4	23%	21%
8	35	33
12	44	42
16	49	49
20	54	54

For our purposes it will undoubtedly be safe to rely on sales to interstate buyers as a guide to the structure of the field market for natural gas.

A second potential pitfall in the interstate figures is that reports are not required for individual sellers for sales of less than 100 thousand M c.f. per year in any given field or sup-

ply area, compared with total sales by the largest seller of 511,000 thousand M c.f. However, many of the large buyers report individual sales individually without the use of a "miscellaneous" category; and the amount aggregated in miscellaneous sales because of low-volume individual sales cannot be very great. A summary by the F.P.C. staff indicates that the total of (1) sales by producers having identified sales which amount to less than 100,000 M c.f. per seller and (2) sales listed as "various" and not identified, was only 78 billion cubic feet in 1955, or just over one per cent of all sales to interstate buyers.[16] And this total includes some identified sales.

Related to this question of unreported small sellers is a more important criticism of the data. In some cases all individual sales do not appear (even individual sales greater than 100,000 M c.f.) because the sales are made from a field or gasoline plant which is jointly owned but which is operated by one company that delivers to the pipe line for the other owners. In such an instance, the pipe line sometimes reports the total volume as being attributable to the operator. If the operator acted, in effect, as the agent of the other owners in negotiating the contract, the total volume is not an invalid figure to use when measuring the alternatives available to buyers, since what the buyer faced in that field or at that plant was the one seller. However, in some cases the other sellers negotiated their own contracts with the buyer and were free, in so doing, to sell to other buyers. In such a situation, attributing the total volume to the operator can overstate his share of the market; and the reporting of total volumes under the operator's name occurs in the reports of a number of large buyers, e.g., in the reports of Tennessee Gas Transmission, one of the largest buyers in the country.

TABLE II-3

COMPARISON OF ACTUAL AND REPORTED SALES BY OPERATORS OF SELECTED JOINT VENTURES IN TEXAS RAILROAD COMMISSION DISTRICT 4

Buyer	Operator	Field	1955 Volume Reported by Buyer Under Operator's Name	1955 Volume Actually Owned by Operator	Overstatement	Operator's Total Volume Reported by All Buyers	Overstatement as Per Cent of Total Reported Volume
			MM c.f. at 14.65 p.s.i.				(%)
1. Tennessee	Lyman	Capt. Lucey	6,811	3,657	3,154	9,053	34.8
2. Tennessee	Chicago Corp.	San Salvador	21,080	8,119	12,961	150,237	8.6
3. Transcontinental	Western Nat.	St. Charles	7,016	3,310	3,706		
Tennessee	Western Nat.	San Salvador	11,212	928	10,284		
Total of (3)	Western Nat.		18,228	4,238	13,990	60,731	16.9
4. Texas Illinois	Atlantic	Hagist Ranch	14,690	4,638	10,052		
Tennessee	Atlantic	Mustang Is.	19,710	6,964	12,746		
Total of (4)	Atlantic		34,400	11,602	22,798	124,791	18.3
5. Transcontinental	Sun	Starr County	10,774	4,543	6,231	82,351	7.6

Source: Buyer reports from pipe line annual reports to F.P.C. (F.P.C. Form 2). Volumes owned by operators from producers' annual reports to F.P.C. (F.P.C. Form 301).

Some extreme examples of the considerable errors of overstatement of sales by a given seller which might result from this quirk in the basic data are shown in Table II-3, which covers some important sales in Railroad Commission District 4 of Texas. It is apparent from this table that the reporting system can overstate a seller's own sales. For smaller sellers, e.g., Lyman, the overstatement can be considerable. The table shows that the particular overstatement cited here accounts for 35 per cent of Lyman's total reported sales. However, in the case of the larger sellers shown in Table II-1, the discrepancy is less important. For example, Atlantic's total is shown to contain about 23 billion cubic feet of non-owned gas from the two examples here, relative to total reported sales of about 125 billion. Even if all of this non-owned gas were sold by the owners and Atlantic's true sales were thereby reduced to 102 billion, its share of the market as reported in Table II-1 would fall by only about half a percentage point (from 2.13 to 1.74 per cent) with a corresponding small reduction in the share of the larger sellers as a group. Unless a large seller serves as the operator of many joint ventures where it does not control the supply, the reporting errors should not appreciably affect Table II-1.

Note that it is usually, though not always, the larger companies which serve as operators. Since the reporting tends to overstate an operator's sales, any errors that do exist will in all likelihood tend to make the market appear *more* concentrated than it actually is, in that errors will tend to give the larger firms a higher share of the market than is actually the case, at least the larger firms as a group. However, there will be some tendency for the errors to compensate as among the larger sellers. Large seller A may have a volume overstated because of a joint venture which he operates, but for which

sales are actually made independently by most of the sellers; on the other hand he may have an interest in some other jointly owned field in which sales are made independently but where large seller *B* is the operator and where the total is credited to B. In one case his share is overstated; in the other it is understated. Among the larger sellers who are operators there is, then, a mitigating force present which should tend to minimize overstatements *relative to each other.* But this compensation will not tend to work as between the larger and smaller sellers as groups, since the smaller are less frequently operators and hence have less opportunity to be credited with volumes of other companies. It is even possible that some small sellers might not appear at all in buyers' tabulations because their volumes are totally concealed in volumes attributed to larger operators. Where these small sellers sold independently and could have sold to some other buyer, an error of some small magnitude will occur in the direction of overstating concentration.

Suffice it to say in summary, that there are potential pitfalls present in these data on interstate sales (as is usually the case in economic studies); but the quirks should not be overly important, and the figures should, all other things being equal, give us a reasonably good statistical description of the market.

(2) *Distribution of Reserves*—An alternative measure of market structure without regard to date of contract would be a tabulation of shares of gas reserves held by the larger companies. There are no complete data of this type; and even if there were such data, they would necessarily be rather speculative. Even reserve data for the country as a whole are somewhat speculative because the total reserves in a field are never known precisely until the field is ex-

hausted. However, in the case of estimates of proved reserves for the country as a whole there is a chance of having optimistic estimates offset by pessimistic estimates. With smaller numbers, say the reserves for one company, the chance for offsetting errors decreases. In addition, it would be expected that the distribution of gas sales would correspond in general with the distribution of the reserves which are committed to support those sales, since it usually takes large reserves to make large sales. For this reason, the market structure should be approximated by actual sales even if a reserve tabulation were the ideal measure.

While no perfect set of company reserve figures exists (or could exist), there have been two recent surveys of the matter. A Federal Power Commission study covering such companies as had released data showed that in 1954 the top four sellers had 24 per cent of national total reserves, the top eight had 32 per cent, and the top twenty had 43 per cent.[17] Standard and Poor's Corporation estimated that in 1955 the top four had 27 per cent, the top eight 38 per cent, and the top twenty 53 per cent.[18] This estimation attempted to cover all companies, not just those which had published some sort of information. The following summary shows that these figures are of the same magnitude as those for sales shown in Table II-1 and Table II-2.

Share Held By Top	FPC Reserve Study of 1954	Standard & Poor's Estimate of 1955	Sales to Interstate Buyers in 1955	Sales to All Buyers in Texas in Dec., 1953
4	24%	27%	23%	21%
8	32	38	35	33
20	43	53	54	54

Of the three measures of concentration, the interstate sales are probably best, since they show what happened in the whole producing area; and they are not significantly differ-

ent from total sales. More important, they do not represent an incomplete tabulation of published figures on a basically speculative quantity, as do the F.P.C. data. Neither are they an estimate of speculative quantities, as are the Standard and Poor's data. Of the two reserve tabulations, it is hard to say which is better for four and eight companies; but Standard and Poor's is probably better for twenty companies because any informed guess would doubtless come closer to the actual than would a tabulation which omits some of the top twenty entirely.

(3) *Distribution of All Gulf Coast Sales to Interstate Buyers* —It has been pointed out that the whole national market, at least the part of it where there are interstate sales, is available to a pipe line planning a new line. However, for small expansions, pipe lines must rely chiefly on the area where existing lines are laid. Hence it is necessary to examine the competitive structure of a sub-area. The area chosen for purposes of illustration here is the Gulf Coast, which accounts for almost half of total interstate sales, and which is served by all but two or three of the primary pipe line systems. As defined here, the Gulf Coast area covers Railroad Commission Districts 2, 3, and 4 in Texas, South Louisiana, and Mississippi. Data for this area similar to those shown in Table II-1 for total interstate sales are in Table II-4. These are 1955 volumes of sales to interstate buyers originating along the Gulf Coast. The top four sellers accounted for 26 per cent of such sales, the top eight for 42 per cent, and the top twenty for 67 per cent. As has been pointed out earlier, the reduction of the area covered by a concentration table would be expected to lead to a greater increase in concentration for the larger number of firms than for the first few firms, because there are fewer firms operating in a sub-area than in

the whole market. This happens as between the Gulf Coast and the whole interstate market. However, the difference is not great, as is shown by the following summary:

Share Held by Top	Total Sales to Interstate Buyers	Gulf Coast Sales to Interstate Buyers
4	23%	26%
8	35	42
12	44	52
16	49	60
20	54	67

The market faced by new lines and large expansions of existing lines is better described by the former; that for small expansions is better described by the latter. Neither, as we shall see, could be considered a very concentrated market.

B. The Market in Recent Years

It has been pointed out that tabulations of sales (or of capacity) in a given year are theoretically deficient in evaluating the structure of this market in that it is possible, because of long-term contracts, that in a given period only a few companies might actually have had new gas for sale regardless of how many may have been selling under old contracts. In order to evaluate the structure of the market at a given time insofar as existing alternatives are concerned, we should need to know the distribution of all uncommitted reserves at that time. Such data would be even more speculative than a tabulation of proved reserves of the type discussed above, since they would include estimates of total reserves in undeveloped fields. In any event, the figures are not available. However, a very good approximation to the alternatives that were available at a given time can be had from sales actually made under contracts negotiated at that time. Such figures are available for sales to interstate pipe lines from the same

source used for Tables II-1 and II-4, the pipe line annual reports to the F.P.C. (F.P.C. Form 2).

Of particular interest in studying the competitive structure of the market for natural gas is the period after the recent substantial increases in price (see Tables I-11 and I-12). These higher prices first appeared on a scattered basis in 1951, with more in 1952, and with a general covering of the market in 1953-1954. By 1955 the market price appears to have stabilized, with changes in 1956-1957 being of lesser magnitude. Hence it is in order to try to establish the alternatives available to buyers *in this period*. This has been done here by computing the shares of new sales to interstate pipe lines held by the top 20 sellers during the period 1951-1955 in the whole interstate supply area and in the Gulf Coast sub-area.

(1) *All New Sales to Interstate Pipe Lines, 1951-1955*— Table II-5 shows the distribution by sellers of all new sales to interstate pipe lines in the years 1951-1955, as measured by 1955 volumes sold under those contracts. These are sales from contracts signed during the period; hence the figures show alternatives actually available during the period.

Since these volumes cover only sales that were actually made to interstate buyers, they understate the total *available* supply in that (1) some reserves were not committed and (2) some gas was sold to intrastate customers. As we have seen, decreasing the total covered in a tabulation of concentration tends possibly to increase concentration for the top few firms and almost certainly to increase concentration for larger numbers of firms. Hence the data in Table II-5 probably tend, for this reason, to overstate concentration. On the other hand, part of the sales in the tabulation (probably a small part) represent contract renegotiations which occurred

TABLE II-4

SHARES OF GULF COAST[1] SALES OF NATURAL GAS TO INTERSTATE BUYERS HELD BY THE TWENTY LARGEST SELLERS—AS MEASURED BY 1955 VOLUMES OF ALL CONTRACTS

Seller	1955 Volumes (M c.f. at 14.65 p.s.i.)	Per Cent of Total	Cumulative Per Cent of Total
1. Humble	230,804,207	9.30	9.30
2. Standard (Indiana)	162,694,522	6.55	15.85
3. Shell	133,211,585	5.37	21.22
4. Union Producing	118,948,555	4.79	26.01
5. Gulf	103,560,986	4.17	30.18
6. Atlantic	102,811,190	4.14	34.32
7. Magnolia	93,037,760	3.75	38.07
8. Texas Co.	93,027,265	3.75	41.82
9. Sun	71,625,979	2.89	44.71
10. Chicago Corp.	67,681,701	2.73	47.44
11. Sunray	61,580,236	2.48	49.92
12. Pure	58,328,632	2.35	52.27
13. Tidewater	55,697,656	2.24	54.51
14. Ohio Oil Co.	53,764,194	2.17	56.68
15. Union Oil of Calif.	49,086,681	1.98	58.66
16. Union Oil and Gas of La.	43,781,522	1.76	60.42
17. La Gloria	43,379,425	1.75	62.17
18. Delhi-Taylor	37,471,227	1.51	63.68
19. Superior	36,310,902	1.46	65.14
20. Standard of California	36,174,047	1.46	66.60
Total of 20	1,652,978,272	66.60	
All Others	829,028,842	33.40	
Total Gulf Coast	2,482,007,114	100.00	

Note: 1—Covers South Louisiana, the Texas Gulf Coast (Railroad Commission Districts 2, 3, and 4), and Mississippi (a small part of total).

Source: Computed from pipe line annual reports to the F.P.C. (F.P.C. Form 2).

when buyers obtained larger volumes of gas from sellers in areas covered by pre-1951 contracts; the older part of such volumes was committed and was, therefore, not available for the market after 1951, while the newer part was available for sale. Hence the total volume shown is somewhat higher than

TABLE II-5

SHARES OF ALL NEW SALES TO INTERSTATE BUYERS HELD BY THE TWENTY LARGEST SELLERS—AS MEASURED BY 1955 VOLUMES OF 1951–1955 CONTRACTS

Seller	1955 Volumes (M c.f. at 14.65 p.s.i.)	Per Cent of Total	Cumulative Per Cent of Total
1. Cities Service	169,818,811	6.64	6.64
2. Shell	120,098,183	4.70	11.34
3. Phillips	118,548,199	4.64	15.98
4. Humble	102,265,682	4.00	19.98
5. Standard (Indiana)	98,099,506	3.84	23.82
6. Union Producing	91,458,329	3.58	27.40
7. Texas Company	87,822,262	3.44	30,84
8. Chicago Corp.	63,860,147	2.50	33.34
9. Magnolia	53,958,559	2.11	35.45
0. Tidewater	53,044,524	2.08	37.53
1. Carthage Corp.	52,455,303	2.05	39.58
2. Southern Production	48,728,927	1.91	41.49
3. Gulf	47,849,626	1.87	43.36
4. Sunray	41,428,093	1.62	44.98
5. Warren	38,508,988	1.51	46.49
6. Delhi-Taylor	38,472,381	1.51	48.00
7. Shamrock	38,067,011	1.49	49.49
8. Union Oil of California	33,881,166	1.33	50.82
9. Union Oil of Louisiana	33,086,728	1.28	52.10
0. Northern Natural Prod.	31,778,843	1.24	53.34
Total of 20	1,363,231,263	53.34	
All Others	1,192,523,727	46.66	
Grand Total	2,555,754,990	100.00	

Source: Computed from pipe line annual reports to the F.P.C. (F.P.C. Form 2).

vas actually sold. For this reason concentration may tend to e understated, thereby compensating in direction the omis- on of intrastate sales and reserves which were available but ot sold. On balance, then, the data should be quite repre- entative of the market as it existed in this period.

Note that for the interstate market as a whole, the top our sellers in this period accounted for 20 per cent of total

sales, the top eight for 33 per cent, and the top twenty for 53 per cent. These figures are all close to the corresponding figures for all contracts regardless of date, as is shown by the following summary:

	Total Sales to Interstate Buyers	
Share Held by Top	All Contract Dates	1951-1955 Contracts
4	23%	20%
8	35	33
12	44	41
16	49	48
20	54	53

The differences are not appreciable, perhaps not significant; and it is safe to say from Table II-5 that the theoretical objection to the use of over-all sales in measuring the structure of this market is not actually justified in this instance. The market in recent years is, by this measure, at least as widely distributed as is the tabulation of all sales.

(2) *New Gulf Coast Sales to Interstate Pipe Lines, 1951-1955*—Table II-6 shows data for the Gulf Coast corresponding to that in Table II-5 for the entire interstate supply area. The top four firms have 27 per cent of 1951-1955 sales, the top eight have 42 per cent, and the top twenty have 67 per cent. Again, these percentages are quite close to those for all sales regardless of contract date, as is shown by the following summary:

	Gulf Coast Sales to Interstate Buyers	
Share Held by Top	All Contract Dates	1951-1955 Contracts
4	26%	27%
8	42	42
12	52	53
16	60	61
20	67	67

TABLE II-6

SHARES OF NEW GULF COAST[1] SALES TO INTERSTATE BUYERS HELD BY THE TWENTY LARGEST SELLERS—AS MEASURED BY 1955 VOLUMES OF 1951–1955 CONTRACTS

Seller	1955 Volumes (M c.f. at 14.65 p.s.i.)	Per Cent of Total	Cumulative Per Cent of Total
1. Shell	93,379,124	8.04	8.04
2. Standard (Indiana)	79,856,940	6.88	14.92
3. Humble	76,790,727	6.61	21.53
4. Texas Co.	66,239,651	5.71	27.24
5. Chicago Corp.	55,320,169	4.77	32.01
6. Union Producing	40,382,374	3.48	35.49
7. Delhi-Taylor	37,471,227	3.23	38.72
8. Southern Production	34,584,528	2.98	41.70
9. Tidewater	34,243,358	2.95	44.65
10. Union (California)	33,567,595	2.89	47.54
11. Sunray Mid-Continent	33,171,251	2.86	50.40
12. Union Oil and Gas (La.)	33,086,728	2.85	53.25
13. Sun	23,489,160	2.02	55.27
14. Union Sulphur and Oil	23,296,469	2.01	57.28
15. California Company	21,674,707	1.87	59.15
16. Cities Service	21,437,930	1.85	61.00
17. Ohio Oil	20,144,732	1.74	62.74
18. Magnolia	18,247,860	1.57	64.31
19. Atlantic	15,638,891	1.35	65.66
20. Hunt Oil	13,927,259	1.19	66.85
Total Top 20	775,950,680	66.85	
All Others	384,913,347	33.15	
Grand Total	1,160,864,027	100.00	

Note: 1—Covers South Louisiana, the Texas Gulf Coast (Railroad Commission Districts 2, 3, and 4), and Mississippi (a small part of total).
Source: Computed from pipe line annual reports to the F.P.C. (F.P.C. Form 2).

The tabulation based on all sales was, then, a valid indicator of the market structure.

As would be expected, Gulf Coast concentration is higher than over-all concentration with a somewhat expanded spread by this measure; this can be seen from a comparison of the final columns in the two preceding summaries.

(3) *Summary*—The market structure indicated by tabulations of over-all sales is almost the same as that indicated by tabulations of recent sales. However, the near statistical equality of the two measures need not persist in the future. One good statistical reason for the equality found here is that just under half the total sales for both the whole interstate supply area and the Gulf Coast were made in the recent period. In the future, current sales should constitute a smaller proportion of total; and a divergence in the concentration patterns would be possible. Hence we shall rely principally on the theoretically preferable tabulations in Tables II-5 and II-6 in later references to market structure of the recent past. It is now in order to turn to an examination of the market in the more distant past, and then to attempt to predict its future structure.

C. Past Changes in the Market Structure

What has been happening to the structure of the field market for gas over time? As may be inferred from the fact that half of total sales in 1955 were under contracts negotiated during the period 1951-1955, the total time for consideration is not long in this industry. Actually, it would probably suffice simply to examine the postwar years, since this would cover nearly all current sales. However, for purposes of comparison one prewar year has been studied in one of the tabulations below. We shall compare sales for the period 1946-1950 for the whole interstate supply area and for the Gulf Coast sub-area with the 1951-1955 tabulations just discussed; and we shall then look at the distribution of all Gulf Coast sales quinquennially from 1940-1955.

(1) *New Contracts in 1946-1950 vs. New Contracts in 1951-*

TABLE II-7

SHARES OF ALL OLD SALES TO INTERSTATE BUYERS HELD BY THE TWENTY LARGEST SELLERS—AS MEASURED BY 1955 VOLUMES OF 1946–1950 CONTRACTS

Seller	1955 Volumes (M c.f. at 14.65 p.s.i.)	Per Cent of Total	Cumulative Per Cent of Total
1. Standard (Indiana)	203,065,020	9.35	9.35
2. Humble	165,326,746	7.61	16.96
3. Magnolia	107,714,604	4.96	21.92
4. Atlantic	94,316,728	4.34	26.26
5. Gulf	90,620,655	4.17	30.43
6. Pure	78,070,664	3.59	34.02
7. Phillips	64,747,947	2.98	37.00
8. Superior	54,466,848	2.51	39.51
9. Ohio	50,464,539	2.32	41.83
0. Western Natural	49,312,217	2.27	44.10
1. Sun	49,185,040	2.26	46.36
2. Shell	46,589,839	2.14	48.50
3. La Gloria	45,472,601	2.09	50.59
4. Cities Service	43,691,321	2.01	52.60
5. Chicago Corp.	41,578,760	1.91	54.51
6. Texas Company	38,034,471	1.75	56.26
7. Sid Richardson	32,817,139	1.51	57.77
8. Sunray	30,692,534	1.41	59.18
9. Continental	30,311,557	1.40	60.58
0. Standard of California	25,592,670	1.18	61.76
Total of 20	1,342,072,000	61.76	
All Others	830,321,043	38.24	
Grand Total	2,172,393,043	100.00	

Source: Computed from pipe line annual reports to the F.P.C. (F.P.C. Form 2).

955—Tables II-7 and II-8 show shares of 1955 sales made y the top twenty sellers under contracts from the period 946-1950 for the entire interstate market and for the Gulf oast, respectively. The following summary compares shares eld by given numbers of firms in the two time periods, 1946-950 and 1951-1955:

Share Held by Top	Total Sales to Interstate Buyers		Gulf Coast Sales to All Buyers	
	1946-1950	1951-1955	1946-1950	1951-1955
4	26%	20%	34%	27%
8	40	33	53	42
12	49	41	65	53
16	56	48	73	61
20	62	53	78	67

TABLE II-8

SHARES OF OLD GULF COAST SALES TO INTERSTATE BUYERS HELD BY THE TWENTY LARGEST SELLERS—AS MEASURED BY 1955 VOLUMES OF 1946–1950 CONTRACTS

Seller	1955 Volumes (M c.f. at 14.65 p.s.i.)	Per Cent of Total	Cumulative Per Cent of Total
1. Humble	153,460,938	13.04	13.04
2. Gulf	89,491,952	7.60	20.64
3. Atlantic	80,823,118	6.82	27.46
4. Magnolia	74,789,900	6.53	33.99
5. Standard (Indiana)	72,160,310	6.13	40.12
6. Superior	54,096,411	4.59	44.71
7. Pure	53,199,681	4.52	49.23
8. Sun	44,917,425	3.82	53.05
9. La Gloria	42,497,628	3.61	56.66
10. Ohio	33,619,462	2.86	59.52
11. Western Natural	30,433,291	2.59	62.11
12. Sunray Mid-Continent	28,350,867	2.41	64.52
13. Shell	26,918,460	2.29	66.81
14. Texas Company	26,643,809	2.26	69.07
15. Tidewater	21,454,298	1.82	70.89
16. Phillips	20,637,576	1.75	72.64
17. Marine Gathering	19,667,153	1.67	74.31
18. Continental	17,107,020	1.45	75.76
19. Union of California	15,519,086	1.32	77.08
20. Union Producing	15,014,761	1.28	78.36
Total of 20	920,303,146	78.36	
All Others	256,991,711	21.64	
Grand Total	1,177,294,857	100.00	

Source: Computed from pipe line annual reports to the F.P.C. (F.P.C. Form 2).

In both the entire area and the sub-area, the percentage attributable to any number of firms is uniformly lower in the later period. In both there has been a distinct decrease in concentration over time, as measured by a comparison of the first and second halves of the postwar period.

Not only has the share of the market held by any given number of leading firms declined, the make-up of the leading firms has changed. Close inspection of Tables II-5 and II-7 shows that in the interstate market as a whole, only 10 of the 20 leading sellers in the period 1951-1955 were among the top 20 in 1946-1950. Likewise, only three of the top eight in 1951-1955 were in the top eight in 1946-1950; and only one of the top four in 1951-1955 was in the top four in 1946-1950. A similar situation exists for the Gulf Coast (see Tables II-4 and II-6), where 12 of the top 20 in 1951-1955 were in the top 20 in 1946-1950, while two of the top eight and one of the top four in 1951-1955 were in the corresponding group in 1946-1950. Not only, then, has the share of the market held by the larger sellers declined during the postwar period, there has also been considerable movement among the market positions of the larger companies. This indicates a considerable degree of freedom of entry into the industry and means that the market was actually more competitive than is indicated by a simple examination of market shares without reference to company names.

(2) *All Contracts, 1940-1955*—An alternative approach to examining the structure of the market over time is to tabulate sales made in various years ignoring contract dates, not sales made in 1955 under contracts with various dates. This was done for the years 1940, 1945, 1950, and 1955 for the Gulf Coast. It was necessary to make manual computations; and the labor required for such computations for the whole

interstate supply area rendered such a task infeasible with any reasonable expenditure of resources. However, the Gulf Coast has moved with the whole market by the measures used above; and it is doubtless indicative of what would be shown if the whole market were analyzed for the four years.

Table II-9 shows the top 20 Gulf Coast sellers to interstate pipe lines in each of these years as indicated by their volumes of sales *in those years,* not in 1955 as in Tables II-6 and II-8. Note that in the very low-volume market of 1940, when total sales were only 3 per cent of the 1955 level, the largest firm had 26 per cent of the total volume of sales, the same share held by the four largest sellers in 1955. The largest firm was three times the size of the next largest, and the whole market was more concentrated than it is today. However, the largest firm in 1940 was a pipe line subsidiary, Union Producing,[19] which sells almost exclusively to its parent, United Gas. As among the non-integrated producers, relative sizes were much closer together; hence even in 1940 the market structure was not much different among the non-integrated producers from what it is today, even though there was one integrated firm considerably larger than the others.

The table shows a distinct increase in concentration by 1945. This is attributable primarily to the entry into the market of Tennessee Gas Transmission, which was organized by Chicago Corporation, the largest seller in 1945;[20] again the large sellers were integrated with pipe lines, and most of their output went to the parents. The volume of sales in 1945 was low, with the total amounting to only 12 per cent of the 1955 total.

When the market began to develop in size after the war, many non-integrated producers entered the market; and concentration began to decrease. Table II-9 shows a marked de-

crease in the cumulative percentages accounted for by any given number of firms as between 1945 and 1950. The total volume in 1950 was still relatively small, amounting to only 30 per cent of the 1955 level. A further distinct decrease in concentration occurred as the market continued to expand so that the top four sellers accounted for 26 per cent of sales in 1955, as compared with 45 per cent in 1940, 59 per cent in 1945, and 36 per cent in 1950.

As was the case between 1946-1950 and 1951-1955, examination of company names in Table II-9 reveals a considerable change among the top 20 sellers. Of the top 20 in 1955, only 9 were in the top 20 in 1940, 8 in 1945, and only 13 as late as 1950. The last is especially indicative of movements of positions among the leaders. With long-term contracts operating there is a cumulative effect that tends to keep a large seller in a tabulation of sellers which ignores contract dates, even though that company may not be making new sales at the former rate; thus Humble, for example, stands first in total sales in 1950 and 1955, but it was third in new contracts in the period 1951-1955. Of the top eight sellers in 1955, four were in the top eight in 1940, five in 1945, and five in 1950, with considerable shifting of position. Three of the top four in 1955 were in the top four in 1940 and also in 1945 (but not the same three); and two were in the top four in 1950.

Also significant in the changing market structure shown in Table II-9 is the change in the gradation of the concentration picture. It has been pointed out that in 1940 the largest seller was three times the size of the second. In 1945 and 1950 the largest firms were twice the size of the second and there was a different leader in each year. However, by 1955, the largest was only half again as large as the second; and

TABLE II-9

SHARES OF GULF COAST[1] SALES TO INTERSTATE BUYERS HELD QUINQUENNIALLY BY THE TWENTY LARGEST SELLERS, 1940–1955—AS MEASURED BY TOTAL VOLUMES IN EACH YEAR

1940				1945			
Seller	1940 Volumes (MM c.f.)	Per Cent of Total	Cumulative Per Cent of Total	Seller	1945 Volumes (MM c.f.)	Per Cent of Total	Cumulative Per Cent of Total
1. Union Producing	16,292	25.65	25.65	1. Chicago	79,848	26.12	26.12
2. Norden and Morris	5,370	8.46	34.11	2. Union Producing	43,084	14.09	40.21
3. Shell	3,661	5.76	39.87	3. Standard (Ind.)	33,915	11.09	51.30
4. Humble	2,955	4.65	44.52	4. Humble	24,128	7.89	59.19
5. Houston Gulf Gas	2,448	3.85	48.37	5. Fohs Oil	23,309	7.62	66.81
6. Fohs Oil	1,806	2.84	51.21	6. Sun	16,205	5.30	72.11
7. Texas Co.	1,694	2.67	53.88	7. Shell	8,553	2.80	74.91
8. W. Helis	1,524	2.40	56.28	8. Gulf	8,329	2.72	77.63
9. W. P. Luce *et al*	1,253	1.97	58.25	9. Norden and Morris	7,026	2.30	79.93
10. Standard (Ind.)	1,076	1.69	59.94	10. Republic Natural	6,753	2.21	82.14
11. Republic Natural	984	1.55	61.49	11. Mikton Oil	4,818	1.58	83.72
12. Magnolia	904	1.42	62.91	12. Transwestern Oil	4,459	1.46	85.18
13. Midland Gasoline	790	1.24	64.15	13. Kirby Petroleum	3,467	1.13	86.31
14. State Mineral Lease Commission	783	1.23	65.38	14. Continental	3,378	1.10	87.41
15. Millsaps College	731	1.15	66.53	15. Barnsdall Oil	3,378	1.10	88.51
16. J. Alexander	706	1.11	67.64	16. W. L. Goldston	3,199	1.05	89.56
17. Sun	694	1.09	68.73	17. Whitman Drilling	2,055	0.67	90.23
18. Gulf	654	1.03	69.76	18. Pure	2,017	0.66	90.89
19. Sugar Field Oil	507	0.80	70.56	19. H. R. Smith and H. J. Mosser	1,957	0.64	91.53
20. Superior	494	0.78	71.34	20. Texas Gulf Producing	1,837	0.60	92.13
Total of 20	45,321	71.34		Total of 20	281,715	92.13	
All Others	18,185	28.66		All Others	24,035	7.87	
Total Gulf Coast	63,506	100.00		Total Gulf Coast	305,750	100.00	

Note: 1—Covers South Louisiana, the Texas Gulf Coast (Railroad Commission Districts 2, 3, and 4), and Mississippi (a small part of total).
Source: Computed from pipe line annual reports to the F.P.C. (F.P.C. Form 2).

TABLE II-9 (*Continued*)

1950				1955			
Seller	1950 Volumes (MM c.f.)	Per Cent of Total	Cumulative Per Cent of Total	Seller	1955 Volumes (MM c.f.)	Per Cent of Total	Cumulative Per Cent of Total
1. Humble	107,956	14.57	14.57	1. Humble	230,804	9.30	9.30
2. Chicago Corp.	56,519	7.63	22.20	2. Standard (Ind.)	162,695	6.55	15.85
3. Gulf	54,918	7.41	29.61	3. Shell	133,212	5.37	21.22
4. Union Producing	50,690	6.84	36.45	4. Union Producing	118,949	4.79	26.01
5. Standard (Ind.)	41,015	5.53	41.98	5. Gulf	103,561	4.17	30.18
6. Sun	36,369	4.91	46.89	6. Atlantic	102,811	4.14	34.32
7. Superior	22,374	3.02	49.91	7. Magnolia	93,038	3.75	38.07
8. Shell	21,849	2.95	52.86	8. Texas Co.	93,027	3.75	41.82
9. Sunray	19,834	2.68	55.54	9. Sun	71,626	2.89	44.71
10. Magnolia	17,103	2.31	57.85	10. Chicago Corp.	67,682	2.73	47.44
11. Texas Co.	14,210	1.92	59.77	11. Sunray-Mid-Continent	61,580	2.48	49.92
12. Standard of Calif.	13,870	1.87	61.64	12. Pure	58,329	2.35	52.27
13. American Republics	12,699	1.71	63.35	13. Tidewater	55,698	2.24	54.51
14. Union Sulphur	11,633	1.57	64.92	14. Ohio Oil Co.	53,764	2.17	56.68
15. Union Oil of Calif.	11,447	1.54	66.46	15. Union Oil of Calif.	49,087	1.98	58.66
16. Western Natural	9,952	1.34	67.80	16. Union Oil and Gas of La.	43,782	1.76	60.42
17. Gillring	8,523	1.15	68.95	17. La Gloria	43,379	1.75	62.17
18. Sinclair	8,320	1.12	70.07	18. Delhi Taylor	37,471	1.51	63.68
19. Midland Gasoline	7,873	1.06	71.13	19. Superior	36,311	1.46	65.14
20. R. E. Fair	7,691	1.04	72.17	20. Std. of Calif.	36,174	1.46	66.60
Total of 20	534,845	72.17		Total of 20	1,652,978	66.60	
All Others	206,280	27.83		All Others	829,029	33.40	
Total Gulf Coast	741,125	100.00		Total Gulf Coast	2,482,007	100.00	

the gradation of size down the line was gradual. This means that it does not take three or four companies to equal the size of the largest, as would be the case in, say, the steel industry; hence the smaller sellers are more effective competitors for the large ones. This is not to say that there has ever been a dominant firm in the market, since the record high of 26 per cent held by the leaders in 1940 and 1945 may well not have been enough for effective market control. Furthermore, as has been noted, these were integrated sellers which did not sell in the open market and which, therefore, might have been able to exercise little influence on it with an even higher share of total sales (it is not inconceivable that their parents might not have had some degree of monopsony power over the market). And there has never been any great disparity among the sizes of non-integrated producers ranked by size. Nonetheless, the area is certainly no less competitive for not having one seller with a fourth of total sales; and it is probably considerably more competitive.

(3) *Summary*—The only conclusion which can be drawn from Tables II-7, 8, and 9 is that concentration in the field market for natural gas has decreased, and decreased substantially with the great postwar expansion of the market. Any suggestion that the pipe lines were forced to rely on progressively fewer sellers in this period of market growth will not bear statistical inquiry. The distribution of sales was rather widespread in the earlier years, as is shown by the 1950 data; and it has become still more widespread as the market has grown at an even greater rate in the latter part of the postwar period.

D. Future Market Structure

We have inquired at length into the structure of the field market for natural gas in the recent and more distant pasts,

with "distant past" in this rapidly growing industry not going back very many years. What can we say of the future? While it is not possible precisely to predict the future structure of the industry, a good idea can be had from examining the shares of pre-drilling exploration and of current exploratory and developmental drilling held by the larger firms, to the extent that data are available.

TABLE II-10

ESTIMATED SHARES OF TOTAL DRILLING ACCOUNTED FOR BY LEADING DRILLERS IN THE UNITED STATES IN 1956

Company	Number of Wells[1]	Per Cent of Total	Cumulative Per Cent of Total
1. Texas Company[2]	1,461	2.56	2.56
2. Gulf	1,371	2.41	4.97
3. Standard of California[3]	973	1.70	6.67
4. Humble	905	1.58	8.25
5. Socony	902	1.58	9.83
6. Standard (Ind.)[4]	736	1.29	11.12
7. Sun	543	0.95	12.07
8. Phillips	509	0.89	12.96
9. Continental	479	0.84	13.80
0. Ohio Oil Co.	438	0.77	14.57
1. Sunray	424	0.74	15.31
2. Skelly	411	0.72	16.03
3. Cities Service	392	0.69	16.72
4. Union of California	377	0.66	17.38
5. Amerada	316	0.55	17.93
6. Atlantic	276	0.48	18.41
7. Tidewater	235	0.42	18.83
8. Pure	217	0.38	19.21
Total of 18	10,973	19.21	
All Others	46,138	80.79	
Total United States	57,111	100.00	

Notes: 1— Net interest except where otherwise noted; excludes others' interests wells drilled by the listed companies.
2—Wells operated by this company; includes others' interests, but excludes this mpany's interest in wells drilled by others.
3—Includes some wells in Western Hemisphere outside of the U. S.
4—Estimated by subtracting reported Canadian wells from reported total of U. S. d Canada.
Source: Annual reports to stockholders.

TABLE II-11

ESTIMATED SHARES OF SUCCESSFUL DRILLING ACCOUNTED FOR BY LEADING DRILLERS IN THE UNITED STATES IN 1956

Company	Number of Wells[1]	Per Cent of Total	Cumulative Per Cent of Total
1. Texas Company[2]	1,169	3.31	3.31
2. Gulf	1,163[a]	3.30	6.61
3. Standard of California[3]	811	2.30	8.91
4. Socony	762	2.16	11.07
5. Humble	692	1.96	13.03
6. Standard (Ind.)[4]	564	1.60	14.63
7. Continental	444	1.26	15.89
8. Phillips	420	1.19	17.08
9. Sun	395	1.12	18.20
10. Ohio Oil Co.	373	1.06	19.26
11. Cities Service	323	0.92	20.18
12. Skelly	312	0.88	21.06
13. Sunray	296	0.84	21.90
14. Amerada	291[b]	0.82	22.72
15. Union of California	283	0.80	23.52
16. Atlantic	215	0.61	24.13
17. Tidewater	198	0.56	24.69
18. Pure	147	0.42	25.11
Total of 18	8,858	25.11	
All Others	26,415	74.89	
Total United States	35,273	100.00	

Notes: 1—Net interest except where otherwise noted; excludes others' interests in wells drilled by the listed companies.

2—Wells operated by this company; includes others' interests, but excludes this company's interest in wells drilled by others.

3—Includes some wells in Western Hemisphere outside of the U. S.

4—Estimated by subtracting reported Canadian wells from reported total of U. S. and Canada.

a—Approximate.

b—Estimated by subtracting reported Canadian wells from reported total.

Source: Annual reports to stockholders.

Table II-10 is an approximation of the shares of total drilling for oil and gas in the United States accounted for by 18 of the larger companies. The data are not precisely comparable in that some companies include a certain amount of foreign drilling in the reported data, while the total repre-

ents only drilling in the United States. Any error present ere should overstate the share of the total held by the larger rms. The top four companies drilled 6.7 per cent of the vells, in comparison with the 20 per cent of total gas sales o interstate pipe lines currently held by the top four sellers. This should not be interpreted to mean that there will be a harp decrease in concentration, since the larger companies ften have higher success rates than the smaller companies. The reason for this is that larger companies tend to reply nore heavily on pre-drilling exploration, while smaller companies tend to do much of their exploration with wildcat rilling; hence the smaller companies get more dry holes. Table II-11 shows the proportions of total successful wells eld by the same companies (here in different order because f varying success rates among the companies). The top our successful drillers obtained 11.1 per cent of total hits of as and oil. Again this does not necessarily imply a distinct ecrease in concentration, since sizes of hits vary. Furthernore, these hits include both gas and oil wells, since company data on successful gas wells are available on only a cattered basis. Nonetheless, it is clear from the figures that n the basis of current drilling activity there is no indication f a future increase in concentration in the discovery of gas r of oil).

Since a large proportion of total drilling is represented by evelopmental wells, the data just discussed might possibly nly indicate current market structure in that they represent r the most part development of fields which have already een discovered. A more appropriate measure of the future ould cover exploratory activity, both pre-drilling exploran (such as leasing and seismograph activity) and explorory drilling. Table II-12 shows the shares of total unde-

TABLE II-12

SHARES OF UNDEVELOPED ACREAGE UNDER LEASE HELD BY 20 LARGE COMPANIES IN THE UNITED STATES—MARCH 1, 1956

Company	Undeveloped Acreage	Per Cent of Total	Cumulative Per Cent of Total
1. Shell	16,892,789	5.36	5.36
2. Humble[1]	15,087,263	4.79	10.15
3. Stanolind	13,106,200	4.16	14.31
4. Gulf	12,725,168	4.04	18.35
5. Magnolia	11,455,750	3.63	21.98
6. Sinclair	11,020,622	3.50	25.48
7. Texas Company	10,877,337	3.45	28.93
8. Sun Oil	9,870,419	3.13	32.06
9. Phillips	8,693,970	2.76	34.82
10. Continental	8,642,924	2.74	37.56
11. Standard of California	8,288,860	2.63	40.19
12. Superior	6,670,000	2.12	42.31
13. Amerada	5,622,650	1.78	44.09
14. Pure Oil	5,519,400	1.75	45.84
15. Cities Service	5,355,610	1.70	47.54
16. Carter[1]	5,348,000	1.70	49.24
17. Skelly	4,827,000	1.53	50.77
18. Atlantic	4,410,760	1.40	52.17
19. Union Oil of California	4,294,000	1.36	53.53
20. Ohio Oil Company	3,603,700	1.14	54.67
Total of 20	172,312,422	54.67	
All Others	142,898,931	45.33	
Grand Total	315,211,353	100.00	

Note: 1—Humble and Carter are both affiliates of Standard Oil (New Jersey). These companies are operated independently; however, if both were consideres as a unit, the largest company would have 6.5 per cent of total, the four largest 20.1 per cent, the ten largest 39.3 per cent, and the 20 largest 56.4 per cent (Sunray being next after Union).

Source: National Oil Scouts & Landmen's Year Book 1955–1956. Companies' annual reports to stockholders.

veloped acreage held under lease in the United States by 20 large companies in 1956. The top four companies account for 18 per cent of total, or for 20 per cent if the shares of Humble and Carter, both affiliates of Standard (N.J.), are combined.

TABLE II-13
SHARES OF GULF COAST WILDCAT DRILLING ACCOUNTED FOR BY LEADING DRILLERS IN 1955

Company	Number of Wells[1]	Per Cent of Total	Cumulative Per Cent of Total
1. Humble	38	1.89	1.89
2. Sun	35	1.74	3.63
3. Placid	33	1.64	5.27
4. Texas Co.	30	1.50	6.77
5. Shell	26	1.29	8.06
6. Sinclair	22	1.09	9.15
7. Continental	19	0.94	10.09
8. Standard (Ind.)	17	0.85	10.94
9. Standard of California	16	0.79	11.73
0. Union of California	16	0.79	12.52
Total of 10	252	12.52	
All Others	1,761	87.48	
Total Gulf Coast	2,013	100.00	

Note: 1—Net interest except where otherwise noted.
Source: Confidential.

This is a figure quite close to the current share of gas sales held by the four largest sellers.

Table II-13 shows the shares of 1955 wildcat exploratory drilling held by ten of the larger companies on the Gulf Coast (nation-wide data are not available except on a scattered basis). Here the percentage is very small indeed. The top four companies have seven per cent and the ten have 13 per cent. Since, as was just noted, the larger companies tend to substitute pre-drilling exploration for wildcat drilling, it would be expected that they should have a smaller share of total wildcats. This table may be compared with Table II-14 which shows the share of total seismograph crew months contracted for by the twenty largest companies in 1956. The top four companies account for 24 per cent (or for 27 per cent if the shares of Humble and Carter are aggregated), while

TABLE II-14

SHARES OF TOTAL SEISMOGRAPH EXPLORATION CREW MONTHS HELD BY THE 20 LARGEST EXPLORERS IN 1956

Company	Crew Months	Per Cent of Total	Cumulative Per Cent of Total
1. Texas Company	492	7.22	7.22
2. Shell	429	6.30	13.52
3. Standard of California	359	5.27	18.79
4. Standard (Ind.)	335	4.92	23.71
5. Phillips	332	4.87	28.58
6. Gulf	326	4.78	33.36
7. Humble	317	4.65	38.01
8. Magnolia	317	4.65	42.66
9. Sinclair	272	3.99	46.65
10. Continental	269	3.95	50.60
11. Carter	245	3.60	54.20
12. Amerada	243	3.57	57.77
13. Sun	232	3.41	61.18
14. Atlantic	218	3.20	64.38
15. Pure	206	3.02	67.40
16. Tidewater	155	2.28	69.68
17. Sunray	127	1.86	71.54
18. Standard (Ohio)	109	1.60	73.14
19. Skelly	106	1.56	74.70
20. Cities-Service	95	1.39	76.09
Total of 20	5,184	76.09	
All Others	1,629	23.91	
Grand Total	6,813	100.00	

Source: Company data confidential.
Total from Interstate Oil Compact Commission.

the top twenty companies have about 76 per cent. Concentration of future discoveries and the sales which will result therefrom should lie somewhere between the distributions of exploratory drilling and seismograph crew months.

In conclusion, it may be said that there is clearly no reason to expect the future structure of the production of gas and oil to be any more concentrated than the past. This conclusion assumes that small firms will not engage in widespread sales

of successful properties to large firms. This has been most uncommon in recent years, and there is no reason to expect such a development in the future.

E. Conclusion

The preceding tables have shown that the field market for natural gas is characterized by the existence of a number of alternative sources of supply. Past, present, and future we find sales to interstate buyers distributed among a number of sellers. In recent years, the 20 leading sellers in the whole interstate market have just over half the total sales, while the four leading sellers have one-fifth of total. What is the economic significance of such a market structure?

This is distinctly not a case of competition among the few. Indeed, in comparison with other industries concentration is low. Recent tabulations from the 1954 *Census of Manufactures* show that 315 out of 426 manufacturing industries, or 74 per cent of total, had a concentration ratio of 20 per cent or more for the first four firms, as measured by value of shipments.[21] The comparable figure for all recent sales of gas to interstate buyers is 19.98 per cent. Hence about three-fourths of manufacturing industries are more concentrated than is the field market for natural gas.

It is important to note in comparing concentration in gas production with that in other industries that the same firms have not always been the leaders, as is often the case in many industries. A concentration ratio of 20 per cent for the same four leading firms year after year indicates a less competitive situation than a concentration ratio of 20 per cent for four differing leaders. In the latter case, there is movement among the leaders; hence there is clearly competitive rivalry among them. When the concentration ratio for the top four firms is

as low as 20 per cent, this point is not too important because the industry is probably competitive in any event; but movement among the leaders indicates even more competitive behavior.

Relative to other industries, concentration is clearly low. In absolute terms, what does the structure of the field market for gas mean in regard to the importance of the alternative sources of supply available to potential customers? A good-sized new pipe line has a throughput capacity of perhaps 300 million cubic feet per day, or about 110 million M c. f. per year. Table II-6 indicates the number of sellers whom a particular potential buyer for this volume would have had to approach on the Gulf Coast in recent years in order to procure this volume of gas. The largest seller could probably have provided this amount alone, since his 1955 sales to interstate buyers were 93 million M c. f.; and some more may well have gone to intrastate buyers or remained uncommitted. Note that the potential buyer would not by any means have been limited to the largest seller as a source of supply. Any two of the next five could doubtless have provided the gas. Among them, the last six of the top 20 sellers sold enough to interstate buyers for one efficient pipe line. And all other sellers outside the top 20 sold enough for three large lines. There are, then, many alternative sources of supply in this market; and these alternatives are real. No one firm is several times larger than the next smaller, and there are many of sufficiently large size relative to the largest to create significant competition for it. Under these conditions it would be almost inconceivable that any one seller could have any significant influence over price. Clearly, no seller in such a market can, like a monopolist, set price knowing that his customers can take his price or leave it.

Not only is the degree of concentration low, it has decreased over time. Hence entry into the market must be possible. And, as a result, the number of alternative sources of supply available to buyers has increased. At the same time that prices were rising after World War II, the market was being shared by more and more sellers. It is, therefore, most unlikely that pricing was monopolistic in this period. Such indications as we can find indicate that concentration will continue low in the future. There is, therefore, every reason to expect pricing to remain competitive.

CHAPTER III

OTHER FACTORS PERTAINING TO THE COMPETITIVENESS OF THE MARKET

WE HAVE seen that the structure of the field market for natural gas is without doubt compatible with competitive behavior. The degree of concentration is low, and there is no single firm which is large relative to the market. Prices were shown to have risen rapidly from 1952-1955, the period when most of the demand increase discussed in Chapter I occurred. However, the presence of rapidly rising (or falling) prices does not mean that competition is absent from a market. Indeed, when demand rises rapidly, price increases are in order if new capacity is to be created. Such price increases are to be expected in competitive industries. And some economists would doubtless say that the *absence* of rising prices with increases in demand would indicate the existence of administered monopoly pricing.

Can we, then, not conclude without further investigation that the industry is competitive? A competitive structure may well be *prima facie* evidence of the existence of competition. A competitive structure is usually a sufficient, if not a necessary, condition for the existence of effective, workable competition (assuming that there is no collusion). Performance tests may be applied to industries which are highly concentrated in order to determine whether they achieve competitive results in spite of their structure; but it is not often considered necessary to examine the performance of industries which have competitive structures.

Nonetheless, as was pointed out in the introduction, some economists have denied the existence of effective competition in the field market for natural gas. Insofar as these denials arise from a belief that this is a case of competition

among the few, their positions will not stand statistical inquiry. However, there are peculiar circumstances which are (or are alleged to be) present in the field market for natural gas, circumstances which might conceivably lead to noncompetitive prices and outputs in spite of a clearly competitive structure. The important items which have been mentioned in this connection will be discussed in this chapter:

(1) The possibility of "fixed supply";
(2) The problem of the "captive consumer" (also referred to as "inelastic demand");
(3) The allegation of "soft bargaining" by pipe lines;
(4) The allegation of abnormally high profits;
(5) The problem of indefinite pricing clauses.

A. "Fixed Supply"

The discovery of gas is often considered to be merely incidental to the discovery of oil. If additions to gas reserves were in reality wholly a function of drilling for oil and were unrelated to the price of gas, the situation would be analogous to one of "fixed supply." This is a term used by economists to describe a competitive market where price increases bring forth no more production and where price decreases cause no decrease in production. In such a market, price serves its short-run function of allocating available supplies among consumers on the basis of willingness to pay; but it cannot serve its long-run purpose of attracting more capital in response to an increase in demand, since by definition there is only a limited amount of product available. In such a market there may be something to be said for regulating prices in order to prevent price increases which cannot lead to capacity increases and which will only enrich suppliers with abnormal profits. Of course, in order to keep some consumers out of the market, any such regulation would necessitate government rationing in place of the market rationing

that would occur if price were permitted to rise.

This criticism of the gas market does not rest on an allegation that it does not have a competitive structure. Rather, it asserts that even if all conditions for competition were present, competition could not possibly work to attract capital to meet increases in demand and to protect consumers against abnormal profits, as competition does where supply is a function of the price of the product. This clearly is a question of central importance in any evaluation of proposed public policies toward the gas producing industry; hence we must examine its validity.

In the first place, it must be emphasized that the argument applied to gas is a contradiction of the economic theory of joint products. The suggestion that the price of one of a group of joint products does not affect the offerings of that product (and of the other products) is contrary to logic. In a joint product industry it is the *total* revenue from the sale of the products relative to the *total* cost of producing the products that determines the level of activity of the industry. Should the price of one joint product rise in response to a change in its demand, the total profit picture will improve; and in a competitive industry which has been in equilibrium, expansion of industry capacity will be stimulated. As in single-product cases, the new capacity will cause a return to normal profits (through reactions on the prices of all products); but the revenue from any one product will certainly affect the total effort. Where it is possible to vary the proportions of the joint products, an increase in the price of one relative to the price of the others will stimulate increased production of that product relative to the others. Of course, if the product whose price has risen provides only a negligible share of the total revenue, the effect on the total will be small; but some effect there will be.

This *a priori* reasoning fits the actuality of natural gas. In the period 1952-1956, the petroleum industry added just under 6 M c. f. of gas to reserves for every barrel of crude oil added, as is shown in the following summary:

Gross Additions to Total Reserves of Crude Oil and Natural Gas in the United States—1947–1956

Period	Crude Oil (000,000 bbls.)	Natural Gas (000,000 M c.f.)	M c.f. of Gas Per Barrel of Oil
1947–1951	15,366	65,656	4.2
1952–1956	15,821	91,266	5.9
Absolute Change	+455	+25,610	
Per Cent Change	+3.0%	+39.0%	

Source: Computed from annual reserve tabulations of the American Petroleum Institute and the American Gas Association (1951 and 1952 oil reserves were averaged for Texas to offset the effects of an unusually high year followed by an unusually low year).

With oil selling at 3 dollars per barrel, gas would have had to sell for 50 cents per M c. f. if the products were to be of equal importance in generating revenue. Actually, sales of new gas probably averaged closer to 15 cents. Hence gas accounted for perhaps 20 per cent of the total value of discoveries; this is less than half, but it is not a negligible part of total. At 6 M c. f. per barrel, a 10-cent increase in gas prices would be the equivalent of a 60-cent increase in oil prices (or a 20 per cent increase in oil prices). Hence, even if gas and oil were joint products which are discovered and produced in invariant proportions, gas revenues would not constitute an insignificant part of total revenues. It would, therefore, be incorrect to assert that gas prices do not affect the supply of gas at all; and it would be highly questionable to classify the effect as unimportant in recent years. In the 1930's, when the price of gas was 2-3 cents, the effect may well have been nearly negligible in many areas.

Not only does gas provide a significant part of total revenue, this is also not a case of invariant proportions. This should be clear from the foregoing table. Note that gross additions to crude oil reserves were up about 3 per cent in the five year period 1952-1956 over 1947-1951, while gross additions to gas reserves rose by 39 per cent. And this is not a full measure of changing proportions because these gas reserve data include oil-well gas which is associated with or dissolved in oil. Since the supply of this type of gas is much more closely related to the supply of oil than is the case for non-associated (gas-well) gas, it would be expected that the increase in non-associated reserves would be even greater.

The American Gas Association, source of the data above, does not publish information on *additions* to non-associated reserves. However, it does release total non-associated reserves as of the end of each year, as well as the total of all gas reserves. While these figures cannot be used to measure changes in gross additions over time, they can be used as the basis of an approximation of gross additions to non-associated reserves for the country as a whole in the period 1952-1956. From 1951-1956 the ratio of non-associated to total reserves fluctuated around 68-69 per cent, with 1956 between 67 and 68 per cent. In the same period, gas-well gas production as reported by the Bureau of Mines remained very close to 67 per cent of total production (this total includes gas produced and returned to the earth in liquid conservation programs, amounting to perhaps 15 per cent of the total).[22] Since the relationship of total non-associated reserves to the total of all gas reserves remained rather constant around 68 per cent and since non-associated gas accounted for a rather constant share of production around 67 per cent, it is safe to conclude that the share of gross additions held by non-

associated gas from 1952-1956 was approximately the same as the share of total reserves held by non-associated gas. (It is something like a baseball player who has a season-long average of .333 and who gets 1 for 3 each day.) Gross additions to gas reserves of all types were 91.3 trillion cubic feet in the period 1952-1956 (see the table above); at 68 per cent of total, gross additions to non-associated reserves were about 62 trillion. A similar computation for earlier years would be invalid because the ratio of gas-well production to total was changing. Even the recent figure is only an estimate, but it gives us some idea of the magnitude of non-associated gross additions.

In order to provide acceptable data on changes in non-associated reserves, Humble Oil & Refining Company has made available its own tabulations of industry non-associated reserves for the States of Texas and New Mexico and for the Gulf Coast of Louisiana. Gross additions to industry non-associated reserves in these areas, as computed by Humble, were 47.5 trillion cubic feet from 1952-1956. In comparison with our estimate of 62 trillion for the country as a whole, this indicates that the areas covered provided 75 per cent of the new non-associated reserves. Hence these areas should be an acceptable guide to the change in total non-associated reserves. The following summary shows changes in crude oil and non-associated gas reserves for these areas in the two periods 1947-1951 and 1952-1956. Note that the ratio in the third column is non-associated gas to oil, not total gas to oil as in the preceding summary.

In this area non-associated gas reserves, the type which should be most responsive to price changes, rose 88 per cent in the second five-year period while crude oil reserves rose only 13 per cent. It is clear from these data that proportions

GROSS ADDITIONS TO RESERVES OF CRUDE OIL AND NON-ASSOCIATED GAS IN TEXAS, NEW MEXICO, AND SOUTH LOUISIANA—1947–1956

Period	Crude Oil (000,000 Bbls.)	Non-Associated Gas (000,000 M c.f.)	M c.f. of Non-Associated Gas Per Barrel of Oil
1947–1951	8,479	25,175	3.0
1952–1956	9,572	47,309	4.9
Absolute Change	+1,093	+22,134	
Per Cent Change	+12.9%	+87.9%	

Source: Computed from data compiled by Humble Oil & Refining Company.

are variable as between oil and gas and that they have varied over time. Furthermore, gas discoveries increased sharply in a period when gas prices rose sharply.

The two areas for which prices were computed above, South Louisiana and Railroad Commission District 4 (the Louisiana and lower Texas Gulf Coasts), may be used to illustrate the correspondence of price increases and gross additions to non-associated reserves in drilling areas where gas is important. Total gross additions to non-associated reserves in these two areas from 1952-1956 were 29.3 trillion cubic feet, or 47 per cent of the estimated national total of 62 trillion cubic feet. Hence a substantial share of all gross additions are covered in the two areas. Furthermore, they are what might be called "gas areas," in that the ratio of non-associated gas additions to crude oil additions is higher than average. For the country as a whole this ratio was about 4 to 1 from 1952-1956 (62 trillion cubic feet divided by 15.5 million barrels). For Texas, New Mexico, and South Louisiana the preceding table showed 5 to 1 in the same period. Both South Louisiana and Southwest Texas have higher ratios. South Louisiana, where both oil and gas are important, has a ratio of 6 to 1; Southwest Texas, where gas is very important, has a ratio of 12 to 1. The two areas, then, have

ignificant gas reserves and high gas to oil ratios; hence they vill serve as acceptable examples of regions where gas prices an be expected to affect gas supply if they will ever affect it.

The following summary compares average prices and ross additions to non-associated reserves in the two periods:

Gas Prices from New Long-Term Contracts Compared with Gross Additions to Non-Associated Reserves in South Louisiana and Southwest Texas—1947–1956

Period	South Louisiana			Southwest Texas		
	Average Life-of-Contract Price (¢ Per M c.f.)	Gross Additions (000,000 M c.f.)	M c.f. of Gas Per Barrel of Oil	Average Life-of-Contract Price (¢ Per M c.f.)	Gross Additions (000,000 M c.f.)	M c.f of Gas Per Barrel of Oil
947–1951	10.6	8,077	5.8	7.5	6,005	7.4
952–1956	19.7	15,712	6.3	12.5	13,592	12.0
Absolute Change	+8.9	+7,635		+5.0	+7,587	
Per Cent Change	+86%	+94.5%		+67%	+126.4%	

Source: Prices from Tables I-11 and I-12.
Reserves from Humble Oil & Refining Company.

In both of these areas there were also substantial in-reases in additions to oil reserves (81 per cent in South ouisiana and 40 per cent in Southwest Texas); but the gas creases were greater, especially in Southwest Texas. The ble shows an unquestionable correlation between increases gas prices and increases in gross additions to non-associ-ed reserves. Hence it is tempting to conclude forthwith at the price of gas is determinative of gas supply, at least non-associated gas supply which accounts for two-thirds total.

However, it is a basic proposition of elementary statistics at correlation between Y and X does not necessarily mean usation of Y by X. Only when there is a good *a priori*

reason for anticipating causation, may it be inferred from correlation. Here there is such a reason, viz., that when the price of one of two joint products rises relative to the other, production of that product will be relatively stimulated to the extent that proportions are variable. Crude oil prices in 1956 were less than 10 per cent higher than in 1947, while gas prices rose sharply. And the data show clearly that proportions have varied in this industry. It is doubtless no historical accident that substantial gas price increases are associated with substantial development of new gas reserves. Accentuated gross additions to gas reserves have in all likelihood been the result of higher prices of gas, at least in the case of non-associated reserves. This correlation is no coincidence.

In addition to the *a priori* expectation which supports the logic of a conclusion of an important causative relationship between higher prices and increased additions to reserves, it is possible to provide some statistical verification which shows that there is drilling for gas and that it has fluctuated with relative changes in the prices of oil and gas. Table III-1 shows successful oil, gas, and condensate wildcats and other exploratory wells from 1946-1956 for the United States as a whole. Gas and condensate wildcat (new field) discoveries increased rather steadily over the period, concurrent with the growth in total exploration. The percentage of total successful wildcat wells seems to have fluctuated on a rather random basis around 28 per cent. The period 1951-1953 was uniformly lower, but this probably has little significance, since wildcat exploratory success rates for any given type of drilling may vary considerably from year to year by chance. The results of wildcat exploration in terms of oil and gas can be controlled in advance only by major shifts from "oil areas" to "gas areas," e.g., from West Texas, where the non-associ-

Year	Oil		Gas		Condensate		Gas and Condensate		Total	
	No. of Wells	Per Cent of Total	No. of Wells	Per Cent of Total	No. of Wells	Per Cent of Total	No. of Wells	Per Cent of Total	No. of Wells	Per Cent of Total
					I. *Wildcats*					
1946	236	70.9	65	19.5	32	9.6	97	29.1	333	100.0
1947	274	69.5	96	24.4	24	6.1	120	30.5	394	100.0
1948	366	73.0	97	19.4	38	7.6	135	27.0	501	100.0
1949	364	71.9	86	17.0	56	11.1	142	28.1	506	100.0
1950	411	69.4	137	23.2	44	7.4	181	30.6	592	100.0
1951	515	75.3	109	15.9	60	8.8	169	24.7	684	100.0
1952	556	75.0	117	15.8	68	9.2	185	25.0	741	100.0
1953	581	75.1	131	16.9	62	8.0	193	24.9	774	100.0
1954	639	70.9	188	20.8	75	8.3	263	29.1	902	100.0
1955	659	71.8	176	19.2	83	9.0	259	28.2	918	100.0
					II. *Extensions and New Pools*					
1946	526	65.4	207	25.8	71	8.8	278	34.6	804	100.0
1947	707	71.8	229	23.3	48	4.9	277	28.2	984	100.0
1948	732	76.1	158	16.4	72	7.5	230	23.9	962	100.0
1949	1,042	78.7	199	15.0	83	6.3	282	21.3	1,324	100.0
1950	1,172	82.4	162	11.4	88	6.2	250	17.6	1,422	100.0
1951	1,248	81.4	219	14.3	66	4.3	285	18.6	1,533	100.0
1952	1,220	76.5	263	16.5	111	7.0	374	23.5	1,594	100.0
1953	1,400	73.5	386	20.2	120	6.3	506	26.5	1,906	100.0
1954	1,346	74.5	343	19.0	117	6.5	460	25.5	1.806	100.0
1955	1,577	72.1	451	20.6	159	7.3	610	27.9	2,287	100.0

Source: Wells from F. H. Lahee, "Exploratory Drilling in 19—," June issues of the *Bulletin of the American Association of Petroleum Geologists*, 1946–56.

Percentages computed.

ated gas to oil ratio is less than 1 to 1, to Southwest Texas, where it is 12 to 1; but within any area year-to-year variations will still be considerable. Hence little significance should be attached to these minor variations in the proportion of total United States rank wildcats completed as gas wells.

On the other hand, successful exploration which seeks to extend known gas fields horizontally or to find new pools beneath known gas fields shows a much different picture. Such drilling is clearly primarily for gas, since the extension of gas fields is most likely to give gas, if it gives anything at all. The share of total successful extension drilling which is attributable to gas and condensate wells fell off after 1946 until 1951 and then began to rise. This relative shift in success away from gas and then back to gas in drilling which is primarily either for gas or oil, as the case may be, corresponds to relative movements in oil and gas prices. After the wartime price freeze ended, the price of oil rose sharply in 1946-1947. This made oil even more attractive relative to gas than it had been, since the price of gas remained relatively depressed for five more years; and there were relatively more oil completions. In the type of exploratory drilling where proportions of the joint products *can* clearly be varied, i.e., in exploration around existing fields known to be oil or gas, oil field extensions were preferred. However, the price of gas began to rise sharply in 1951-1952 while oil prices remained almost constant; and thereafter there was a relative shift in favor of gas.

It may be concluded that the price of gas does affect its supply. The widespread assertions that gas discoveries reflect primarily drilling for oil and are largely independent of the price of gas are unsound.

B. The "Captive Consumer"

It has been said that competition does not work well in this industry because consumers are captives of the gas producers once they install gas furnaces. Professor Kahn, testifying against a gas price increase, has put the same point in a different way by stating that regulation is required because demand is "inelastic."[23] The argument is that once a consumer purchases a gas furnace, he is at the mercy of the producer, since any price increases in gas will doubtless be a less formidable economic problem to him than would the purchase of a new furnace. Hence he can be gouged unmercifully by the producers.

To the extent that this is a political argument which asserts that, regardless of competition, industries which are competitive should nonetheless be regulated if their customers are captives so that old customers will not have to pay higher prices should demand increase, it is of little concern here. We are here interested in evaluating the competitiveness of the market; and this sort of policy would be based on non-economic considerations. However, it should be pointed out that economic regulation based on non-economic considerations must be prepared to take the economic consequences. Should price be held below the level it would attain in an unregulated market in order to protect "captive" consumers against price increases when demand increases, the regulatory agency will perforce have to ration the regulated product, since (1) higher prices will not be available to discourage those consumers who want the product least and (2) higher prices will not be available to encourage producers to develop more capacity to produce more of the product.

Furthermore, a public policy of regulating competitive industries when their consumers are "captives" would en-

compass considerably more industries than the production and distribution of natural gas. People who wear shoes are captives of the shoe industry. People who eat bread are captives of the bread industry. People who live in houses are captives of the housing industry. The "captive consumer" is not by any means an unusual situation; but this situation should in itself be of no concern. What matters is whether the industry is monopolistic. The consumer who is a captive of the shoe industry cannot be exploited if there is competition in the shoe industry. When there are alternative sources of supply of shoes, no one shoe manufacturer can extract abnormal profits from the consumer; hence competition protects the "captive."

This does not mean that the shoe consumer will never have to pay higher prices. Apart from over-all price inflation, if the demand for shoes grows and if shoe manufacturing is an increasing cost industry such that more capacity will mean higher per-unit costs of production, then every shoe consumer will have to pay more for his shoes. There is, in this writer's view, no ethical reason for making the new consumer bear the total cost of the increased production because he happened to be born after the existing consumer; this is a risk shoe wearers must take in a free economy. Likewise, it is a risk gas consumers must take. In short, the "captive consumer" argument is largely political, not economic; and it is surprising that economists should give it any more respect than the negative respect it deserves.

However, if "inelastic demand" is present *and* if it interferes with the operation of the otherwise competitive market, the allegation is certainly of interest to our inquiry. (This is the position of Professor Kahn.) As the term is most widely used in economics, "inelastic demand" would exist if an

ncrease in price led to an increase in total revenue, assuming no changes in consumers' basic desires to buy the product. A related concept is that a given percentage increase in price would lead to a smaller percentage decrease in consumption. The textbooks tell us that demand can be either inelastic, elastic, or of unitary elasticity; in the last case relative changes in price equal relative changes in consumption. In none of these cases will competition fail to work simply because demand is either inelastic, elastic, or unitary. The law of supply and demand will work in a competitive situation, regardless of the elasticity of the demand curve (unless it be a strange case like that of diamonds). This is a simple principle of economics.

Professor Kahn probably uses the term as a synonym for "perfectly inelastic." In this case, price may be increased or decreased without affecting consumption. In other words, the demand curve at any given time is vertical. Even in this situation, the law of supply and demand will usually work and there will be an equilibrium price at the price which equates consumers' desires to buy with suppliers' desires to sell. Should demand increase a higher price will result, as in other demand cases; this in turn will attract capital. The traditional responses will occur; and competition will work.

Only if *both* the supply and demand curves are vertical and unequal, will there be a failing of competition. This means that neither producers' offerings nor consumers' takings are responsive to price changes. That is, if supply is fixed and demand is perfectly inelastic, competition will not work. Should producers have one million tons available per year and should consumers want two million tons regardless of price, price will spiral up continuously to no real economic avail because no more can be produced. And this is probably

what Professor Kahn had in mind, since he also asserted that the price of gas does not affect its supply appreciably.[24] In the preceding section we have discussed the problem of fixed supply; it is not present in this industry. If it were and if demand were perfectly inelastic at some other output, Professor Kahn's point would be valid; but the theoretical point simply does not apply in this industry, since supply is not fixed.

Demand is also not perfectly inelastic, except perhaps in the case of home heating (25 per cent of the total market). When the temperature falls in the home, the furnace will be used. However, even in the case of home heating, consumption of gas will doubtless vary to some extent with price. With high costs of heating or cooling, people wear warmer or cooler clothes in the home. If this were not the case, all homes would have central heating and air conditioning; and these would be used endlessly with no consideration of the fuel or electricity bill. This is not the way the American home operates; at least it is not the way a professor's home operates. Industrial consumption of gas, particularly for boiler fuel purposes, is of course highly responsive to price changes; indeed, many electric utilities have furnaces that can burn either oil, coal, or gas at the turn of a knob. Which is used depends on relative prices.

In summary, if demand were perfectly inelastic and if supply were fixed, competition would not work. However, neither of these situations exists in this industry. Hence the "inelastic demand" argument is inapplicable.

C. Pipe Line Bargaining

One of the most disturbing criticisms levied against the competitiveness of the field market for natural gas is, curiously, not levied against the producers at all. Rather it is said

The non-competitive results arise because the principal interstate buyers do not bargain vigorously, as do buyers in most markets.[25] This contention is based on the fact that pipe lines sell, at rates approved by the Federal Power Commission, to regulated local utilities, whose gas costs are valid items in their costs of service. These costs will in turn be allowed in the local utility rate bases by local commissions. Hence the pipe line can supposedly pay anything it wants for gas in the field, thereby saving itself the trouble of bargaining with the producers; and then "with impunity" it passes the imprudent purchases on to its utility customers. It is usually conceded that effective bargaining would result if the true wholesale buyers, the distributing utilities, contacted sellers in the field. However, what actually happens in most cases is that the *carrier* buys the gas from the producer and resells to the utility. The pipe line, having no direct contact with the final market, allegedly does not care what it pays; and it passes the unnecessarily high prices to the distributor, who does care but can take the gas or leave it.

This contention reduces to nothing more nor less than an allegation that the pipe lines which are not affiliated with distributors pay a much higher price for gas than they need pay. In other words, they are said to be imprudent buyers who pay more than would a company operating under honest, efficient, and economical management without benefit of regulation. This is a most serious charge against the pipe lines. And on the surface it is not unconvincing, particularly in view of the fact that no pipe line has yet had a rate increase disallowed by the Federal Power Commission because of excessive payments for gas in the field. Even so, there are distinct weaknesses in the argument. This is not a criticism which lends itself to extensive statistical investigation. The criticism itself is a matter of surmise; and any

evaluation of it must also be largely surmise. Nonetheless, some evaluation is necessary.

In the first place it must be pointed out that a number of pipe line systems are subsidiaries of distributing companies. Important examples are Natural Gas Pipeline-Texas Illinois, Michigan Wisconsin-American Louisiana, United Fuel Gas, and United Gas Pipe Line (the largest buyer of all). Reference to Table I-6 will show that these companies account for a good part of long-distance transmission capacity. In these cases it *is* the distributor who bargains through his alter ego, the transport subsidiary. Furthermore, other distributors have dealt directly with producers and have used the pipe lines only as transporters hauling gas for a transport fee. Two important examples of this in the interstate market are: (1) a purchase by Manufacturers Light and Heat Company from Champlin Refining (formerly Chicago Corporation) and (2) a purchase by Iroquois Gas from Shell (see Table III-2 below). Both of these sales on the Texas Gulf Coast are hauled East by Tennessee Gas Transmission Company, a non-integrated carrier. While this situation is not too common in interstate sales, it is also not beyond achievement for any distributing utility which would prefer to do its own bargaining with producers. Direct sales from producers to integrated pipe lines, such as Lone Star and United Gas, or to final industrial customers are quite common in intrastate selling.

It is interesting to note in this connection that the first 20-cent prices paid for gas in the Southwest were negotiated in 1952 and 1953 in South Louisiana (see Table I-11 above) by United Fuel Gas and American Louisiana, both pipe line subsidiaries of Middle Western distributing companies. Likewise, the first 12-cent prices in Southwest Texas were negotiated late in 1951 (see Table I-12) by United Gas Pipe Line, an integrated carrier. Late in 1952 Iroquois Gas, an Eastern

istributor, bought gas directly in the sale mentioned above t a starting price of 16½ cents, a price not yet surpassed on he Texas Gulf Coast. Hence it appears that the highest rices are not unpalatable to the distributors, since they were nitiated by pipe line affiliates of distributors. Since the criti- ism of "soft bargaining" because of a lack of interest in the nal market must perforce be directed against non-integrated nes, the argument loses some of its force when it is realized hat integrated lines have led in increasing prices paid to roducers.

In the second place, it must be pointed out that most of the on-integrated pipe lines sell important amounts of gas di- ectly to industrial customers under non-regulated contracts. Vhile these are sales in interstate commerce, they are not ales for *resale* and are, therefore, not subject to the jurisdic- ion of the Federal Power Commission. Any revenues arnered from such sales in excess of the costs of making the ales is money in the pocket of the pipe lines free from egulatory interference. What the non-integrated carrier pays n the field for gas is, therefore, clearly of direct concern to in relation to these sales, even if not in relation to sales to istributors.

Furthermore, it must be recognized that even small price hanges per M c. f. represent sums of money which are im- ortant in total to the pipe lines. A pipe line with a capacity f 300-million cubic feet per day which, in securing its gas upplies, imprudently pays even one penny more per M c. f. han it would have paid after vigorous bargaining with pro- ucers, pays one million dollars more per year. This would be significant sum to such a line, which might require an in- estment of 100 million dollars. Note that on a 100-million ollar investment, the average permitted earnings over the fe of the line would amount to perhaps three million dollars

per year at six per cent of the depreciated initial cost. (Current practice of the Federal Power Commission allows about six per cent on a declining rate base.) That the Federal Power Commission has not yet disallowed a rate increase based on increased gas prices may only mean that it has not yet felt such an increase to be imprudent. Should it disallow the extra penny in this example as imprudent, it would in effect disallow one-third of the maximum profit now obtainable by the line over its life. This would be disastrous to stockholders. Note that the pipe line cannot even safely offer an imprudent price before construction on the chance that the Commission might allow it, with the reservation that the price will be renegotiated should the Commission disallow. Certificates of convenience and necessity are granted with a specific assertion by the Commission that the granting of the certificate does not necessarily approve the rates to be charged as just and reasonable. Hence the line is started before its rates are finally approved. In short, even one penny per M c. f. can represent a most important sum of money to a pipe line—a sum with which it is dangerous to be imprudent, since no Commission is required to allow imprudent expenditures in a regulated company's cost of service.

The fourth, and perhaps the most serious, criticism of the soft-bargaining argument is that buyers possess a distinct bargaining advantage over sellers in nearly all areas, since the buying side of the market is nearly always more concentrated than the selling side. In some instances there is only one important buyer; for example, El Paso Natural Gas buys nearly all of the gas in the Permian Basin of West Texas and New Mexico. This was once the rule in the fields to such an extent that the Federal Trade Commission concluded in a study of the industry in 1940 that,

> . . . more than one pipe line company rarely built gathering lines into any certain portion of a field. This meant that the well owners were absolutely subject to the will and caprice of such company, so that as to well owners, it became a "take it or leave it" proposition.[26]

This is not to say that pricing in the gas fields is now universally monopsonistic. Today, it is much more common to have a number of buyers in each area, but nothing like the wide distribution which we find among sellers. Where sellers face a far smaller number of alternative markets than buyers face sources of supply, it is difficult to see why buyers would concede their bargaining advantages unless the prices they pay are a matter of absolute indifference to them; and the preceding discussion has shown that the price buyers pay in the market is, at the very least, of some significance to them.

The structure of the buying side of the market is indicated in Table III-2, which shows shares of sales to interstate buyers bought by the interstate buyers operating on the Gulf Coast for all contracts regardless of date. This table covers the same sales shown distributed by sellers in Table III-4 above. The following summary compares shares of the market in this area held by the leading buyers and sellers:

Comparison of Structures of Selling and Buying Sides of Gulf Coast Gas Market, as Measured by All 1955 Sales to Interstate Buyers

Share Held By Top	Sellers	Buyers
1	9%	35%
2	16	53
3	21	62
4	26	68
6	34	80
8	42	90
10	47	98

With this considerable disparity in the market structures on the two sides of the market, it is difficult to believe that the pipe line buyers would risk imprudent purchasing which might be disallowed when the bargaining advantage stands so heavily to the buying side.

TABLE III-2

SHARES OF GULF COAST SALES OF NATURAL GAS TO INTERSTATE BUYERS HELD BY EACH BUYER—AS MEASURED BY 1955 VOLUMES OF ALL CONTRACTS

Buyer	1955 Volumes (M c.f. at 14.65 p.s.i.)	Per Cent of Total	Cumulative Per Cent of Total
1. United Gas	876,565,540	35.32	35.32
2. Tennessee	438,650,278	17.67	52.99
3. Transcontinental	217,412,582	8.76	61.75
4. Texas Illinois	165,137,287	6.65	68.40
5. Texas Eastern	148,904,557	6.00	74.40
6. Southern Natural	144,308,147	5.81	80.21
7. United Fuel Gas	130,002,238	5.24	85.45
8. Olin Gas	112,140,305	4.52	89.97
9. Trunkline	104,884,925	4.23	94.20
10. Texas Gas Transmission	97,486,957	3.93	98.13
11. Iroquois Gas	18,250,000	0.74	98.87
12. Manufacturer's Light and Heat	11,502,033	0.46	99.33
13. Texas Gas Pipe Line	11,108,479	0.45	99.78
14. Lone Star	5,632,500	0.22	100.00
15. Southern Union	21,291	X	
Total	2,482,007,114	100.00	

Note: X—Less than 0.005 per cent.
Source: Pipe line annual reports to the F.P.C. (F.P.C. Form 2).

In summary, it is impossible to prove quantitatively that the soft-bargaining accusation is true or false, since it is essentially a qualitative accusation. The accusation gains credence from the fact that the Commission has never disallowed a field gas price as imprudent. It loses much, if not all, of this credence in the light of the four objections just raised. We shall never know with certainty, since no pipe

line would ever admit that it bargained softly; but there is considerable reason to believe that pipe lines do bargain with vigor.

D. Profitability of Gas Production

As we have seen, Professor Glaeser (among others) has hypothesized, without presenting statistical evidence, that profits in this industry are abnormally high. We have also seen that persistent abnormal profits are incompatible with competition, although they serve a necessary purpose from time to time. Should there be such profits in the production of natural gas, serious questions would be raised about the competitiveness of the industry. We must, therefore, inquire whether profits in the recent period of rapid price increases have reached abnormally high levels.

Since gas is a joint product, it is impossible to determine precisely the profit made on gas by the industry or by a company, especially in the case of oil-well gas. Such a determination would require an allocation of the joint costs, notably the exploration costs for gas-well gas and nearly all of the costs for oil-well gas. All allocation of true joint costs is arbitrary and without economic significance. True joint costs are those not directly attributable to any one product. Such costs will exist whether a given product is sold or disposed of as waste. These costs are a function of the over-all level of operations and are independent of the relative value of the products, the relative weight of the products, the floor space devoted to each product, etc. Ascribing any particular part of costs which result from the whole operation to any one product is meaningless and accomplishes nothing.

However, as we have seen above, it is possible to vary proportions in this industry to a considerable degree. There is actually drilling which is primarily for gas; and over-all drill-

ing programs in gas areas are doubtless greatly influenced by the discovery ratio of gas to oil. Hence it might be permissible in attempting to evaluate the profitability of gas production under the recent price structure, to assume that we have conducted a drilling program and achieved success only with gas wells (including condensate). If a few of the wells had been oil instead of gas, the resulting revenues and costs would be somewhat different; but we shall content ourselves with the evaluation of an investment program which gives us only gas. In order to approximate average industry profits under these conditions, we shall assume average industry success in the number of successful wells and in reserves developed per well; average industry costs of finding, drilling, and producing; and average prices—all in the recent period in which we are interested. Costs and revenues will be expressed as average outlays and receipts per productive well.

In the period 1952-1956, the five years including and following the rapid price increases, the industry completed 20,941 successful gas wells (including condensate wells).[27] It was estimated above that 62 trillion cubic feet of non-associated gas were added to reserves in this period. On the average, then, a gas well developed about 3 billion cubic feet of reserves (62 trillion divided by 20,941 wells). Each gas well also added an average of 75 thousand barrels to condensate reserves. At an average price of, say, 15 cents per thousand cubic feet for new gas under long-term contracts during this period, the value of the gas in the average well would be $450,000. At an average condensate price of about $3 per barrel, the value of the condensate would be $225,000. This gives a total revenue from a typical gas well of $675,000. Typical royalties are ⅛ of total, with some

higher; hence an average royalty might be 15 per cent. This would mean that about 85 per cent of gross, or $574,000, would typically be left to the operator to cover his costs. In round numbers, then, we may say that the average gas well will generate about $575,000 for the producer. How much would it cost?

The 1954 Census of Mineral Industries shows an average gas well drilling cost of $69,200 in 1954.[28] This figure covers drilling and equipping of wells. To this we should add $5,000 to $10,000 for general field investment, say $7,000. This gives a total investment of about $76,000 in each productive well.

Allowance must also be made for exploration costs, both dry hole and pre-drilling exploration costs. The latter cover primarily geological and geophysical work and leasing. Although it is not generally recognized, such costs actually outweigh the drilling and equipment costs of productive wells. Data on pre-drilling costs are available for 1953; and dry hole costs are available for 1954. A prerequisite to converting these into costs per productive well is the computation of the average number of productive hits we might expect in a gas drilling program.

If, as we have assumed, a given drilling program resulted in gas with industry average success in the number of productive hits, we should expect about 11 per cent success for wildcat wells, which discover about one new field in nine tries.[29] For development wells, the rate of hits should be about 80 per cent. In the period 1953-1955, the approximate years when most 1953 pre-drilling exploration would have resulted in drilling, the industry discovered 715 new gas fields and drilled 12,717 gas wells, an average of 17.8 wells per field.[30] Since one of these is the discovery well, there

would be 16.8 productive development wells on the average in every field. Each discovery well requires eight dry holes (11 per cent success), and every eight development wells require two dry holes (80 per cent success). We should, therefore, expect eight wildcat and four development dry holes for the 17.8 productive wells, or roughly two dry holes for every three producers. This would mean an average success rate of about 60 per cent, and it would require that every productive well bear the cost of two-thirds of a dry hole.

The 1954 Census cited above showed an average dry hole cost of $34,900 (per dry hole). This reflects dry holes in both oil and gas fields and in unsuccessful territory. Gas drilling is deeper than oil drilling by 765 feet per well according to the Census; hence gas-wells are more expensive than oil wells. Average dry hole costs from a (deeper) gas-drilling program should, therefore, be somewhat higher than the Census average for all wells. Productive gas wells at an average cost of $69,200 were 31 per cent more expensive than the average cost of all productive wells of $52,900. Since the Census dry holes come from combined oil and gas drilling, gas drilling might be expected to encounter dry holes costing 31 per cent more than the average cost of all dry holes, or about $45,000 per well. The additional $10,000 is basically attributable to the greater average depth. Since there are two dry holes for every three producers, each productive well must recover the cost of two-thirds of a dry hole costing $45,000, or about $30,000. Hence the dry hole cost to be added to the productive well investment costs is $30,000.

An industry survey in 1953 showed that total expenditures for pre-drilling exploration in that year were $1,159 billion.[31] In the period 1953-1955, the approximate drilling years reflecting most of these expenditures, the industry discovered

an average of 865 new oil and gas fields per year.[32] The total annual expenditure of $1,159 billion in 1953 divided by average annual discoveries in the period 1953-1955, gives an average pre-drilling cost per new field discovered of $1,340,000. We have seen that in the same period there were 17.8 productive gas wells per gas field on the average. Hence the pre-drilling cost per productive gas well would be about $75,000 ($1,340,000 divided by 17.8).

In summary, the average initial outlay for a gas well would be the following:

Drilling Cost	$ 69,000
Field Investment	7,000
Dry Hole Cost	30,000
Pre-Drilling Exploration Cost	75,000
	$181,000

In addition to the initial outlay of $181,000, there will, of course, be yearly operating expenses: lifting costs, overhead, and income taxes. No industry-wide data are yet available on lifting costs and overhead. However, it appears that a typical cost of operating a gas well is $400-450 per month, say $5,000 per year. Administrative overhead expenses might typically be six per cent of revenues after royalty ($34,500 in total). If we assume a producing period of 20 years in accordance with the most common long-term interstate contracts, operating costs would amount to about $135,000 exclusive of income taxes. Income taxes on such an operation would amount to about $90,000, allowing for percentage depletion. Total operating costs over the life of the well would be:

Lifting Costs	$100,000
Overhead	35,000
Income Taxes	90,000
Total	$225,000

An investment of $181,000, then, produces revenue of $575,000 before operating expenses and $350,000 after operating expenses over a period of 20 years ($575,000 less $350,000). This gives a net gain of $163,000 and a nominal rate of return on the initial outlay of nine per cent. This rate of return is computed by dividing the total net gain by 20 and then dividing by half the initial outlay, including exploration costs. (It does not represent the rate of return that would be indicated by using the accounting book investment, including primarily tangible well costs.) On a discounted cash flow basis, the rate of return would be eight per cent. This is the true return on new investment capital if the capital is provided out of funds not subject to income taxation.

If the exploratory expenditures are made by a going concern from income which would otherwise be taxable at the corporate rate of 52 per cent, the out-of-pocket cost for this item is actually only 48 per cent of the figure of $105,000 used above. A large part of the drilling cost of productive wells can also be expensed against other income. If such outlays are expensed against other income, the taxes on the well in question will be higher, since taxes are reduced on other income in the initial year but raised on this income later. The real advantage of expensing against other income comes in postponing the tax obligation and thereby gaining a present-value advantage in having money sooner for reinvestment. In the case of the going concern which postpones the tax, the rate of return on the initial outlay would be 12 per cent, as computed by the discounted cash flow method.

Does a return of 12 per cent exceed what might be considered normal profits in this industry? A full study of the rate of return required for attracting capital to this industry

s beyond the scope of this study. However, it would be expected that the return for average success in drilling should be at least in accord with that offered by other investments. In this event, above-average success will give ucrative returns; and the chance of earning these higher returns will at least partially offset the peculiar uncertainty associated with drilling for hydrocarbons. (This uncertainty s that a given capital expenditure may provide no productive facilities at all if one gets nine instead of eight dry holes out of nine wildcats.)

Some general indication of the return available elsewhere can be had from the 1956 *Fortune* survey of the nation's 500 largest industrial corporations, ranked by dollar sales. This study shows an aggregate profit after income taxes of $11.5 billion from an invested capital of $87.5 billion.[33] This amounts to a rate of return of 13 per cent per year on the average. This is a nominal rate of return and hence should be comparable with the nine per cent figure for the gas investment; however, the *Fortune* nominal rate of return reflects capital investments made partly in periods of lower prices than the present. Hence it is probably somewhat higher than is being earned on new investment, and it is the return on new investment which is the proper measure of alternative investment opportunities available to the potential new investor in natural gas production. Hence, the nominal return on gas is not so much lower than the average for all manufacturing as might be indicated by comparing nine per cent with 13 per cent. In any event, it would be difficult to say that a true (discounted cash flow) return of 12 per cent for average success in drilling in an enterprise s uncertain as the search for gas is abnormally high.

This is not to say that from time to time individual firms

will not make more attractive returns than 12 per cent. The fortunate investor who beats the odds and achieves success substantially higher than average in the number of hits or in the size of fields he discovers will make higher returns. Indeed, it is doubtless this chance of high returns which brings most capital into the industry in view of the chance of total loss. On the other hand, those who fail to beat the odds will do considerably worse than 12 per cent. For the industry as a whole, it is hard to see how any assertion of abnormal profits can bear statistical inquiry.

Before proceeding to the discussion of indefinite pricing, it might be noted that this discussion of costs and returns indicates that entry into the gas producing industry is not restricted by unusually high capital costs of creating new productive facilities, as would be the case in many industries, e.g., automobiles. While free entry is not an absolutely necessary condition for the existence of effective competition if there are sufficient existing firms, it certainly helps to make an industry more competitive. If many millions of dollars are required for the entry of new firms, entry may well not be easy. However, we have seen here that the average industry cost per gas well is $181,000. Hence a respectable investment program can be carried on with an outlay of only a million dollars, and perhaps with less if one beats the industry odds on dry holes.

E. Indefinite Pricing Clauses

The widespread use in gas contracts of "indefinite pricing clauses," which are not to be confused with the specified price schedules discussed earlier, is a result of the almost equally widespread use of long-term contracts. The Federal Power Commission has insisted on such contracts to guaran-

tee gas consumers who install gas furnaces that there will be gas to burn in those furnaces for 20 years. In addition, pipe line bond holders also require about a 20-year supply initially to assure the payment of their indentures. The initial requirement is often 22 years, with the additional two years serving as a safety factor. Indeed, many debentures have an acceleration provision which will reduce the payment period should a pipe line's supply fall below the number of years left on the indenture, plus two. If, for example, after five years of operation a line finds itself with a 10-year supply of gas, the remainder of the debentures would have to be paid in eight years, not in 15 years. This serves as a considerable incentive to the pipe line to contract for a 22-year supply when it builds its line.

While the gas producers might concede that these are good and sufficient reasons for having 20-year contracts, they have sold new gas in the post-war years under the shadow of a disastrous experience with long-term contracts. In the early 1930's there was a combination of flush production in the Southwest and general decreased demand which led to many life-of-lease contracts at 2-3 cents per M c. f. (see Table I-10 above). After a quarter century of inflation and increased demand for gas, some of these contracts are still in force in areas where the going price for new gas is about 15 cents. It is quite conceivable that some of this gas was sold in the past ten years at less than the cost of lifting it. However, a bargain is a bargain; and if the pipe line held the seller to it, the seller lifted the gas. In many of the cases the older pipe lines have granted some price increases, particularly when they were buying new gas in areas where other buyers had appeared after the war. Nonetheless the experience has left its brand on producers, particularly in view of

the common belief that there will be a persistent long-run tendency toward inflation in the economy.

As a result of the pipe lines' need for long-term contracts and of the producers' fear of them postwar bargaining has led to the inclusion in the contracts of a number of "indefinite pricing provisions" designed to assure the producer that his committed gas would be subject to any future gas price increases, as it would if gas were sold like crude oil on a month-to-month basis. The basic purpose of the provisions is to put the gas producer in a position not unlike that of the oil and gas royalty owners from whom the producer buys. The royalty owner's oil and gas are committed for the life of the lease, but he is protected against inflation by having the right to take the oil in kind. In turn the producer is protected by the indefinite pricing provision. The two most common types are:

(1) the "two-party favored nations" clause, by which the buyer agrees to pay the seller the highest price he pays in the future to any other seller in the area; and
(2) the "better market" clause, which provides for periodic redeterminations of prices, commonly on the basis of the average of the three highest prices in the area (or alternatively, this clause simply calls for periodic redetermination based on the market at large, with a floor of the specified price).

Occasionally contracts will contain other clauses, such as:

(1) a "spiral" clause which guarantees the producer a share of any price increases received by the pipe line at the other end of the line;
(2) a clause tying the price to some over-all price index (a provision like the cost-of-living escalations in the General Motors and railroad wage contract); and
(3) a "third-party favored nations" provision, by which the buyer agrees to match the highest price paid by any other comparable buyer in the area.

Since the last three are least important, we shall deal with

them briefly in the beginning and then discuss the others.

The spiral clause is highly questionable, since there is no good reason why a producer should get a price increase because a pipe line has a rate increase approved to offset, say, a pipe line wage increase. If the purpose of the spiral clause is to permit the producer to share in pipe line rate increases which are caused by higher prices paid to other gas producers, then it is an (imperfect) favored nations clause. As such it is subject to more or less the same comments as the two-party favored nations clause, which we shall discuss presently.

The escalations tying prices to movements of, say, the wholesale price index seem to be a defensible device for producers to use as a defense against inflation or for pipe lines to use as a defense against deflation. It is not unlikely that this device, already accepted in labor contracts covering much shorter periods, will become more common in gas contracts, particularly in those for industrial use.

The "third-party favored nations" clause is also not too common. It is a hybrid of the "two-party favored nations" and the "better-market" provisions. In the former the buyer agrees to pay the highest price *he* may pay anyone else; in the latter the buyer agrees to pay the average of prices paid by others. In the third-party clause the buyer agrees to pay the highest price paid by any *one* other seller. As such, this clause is less defensible than either the two-party favored nations or the better-market provisions, since it leaves any buyer who uses it at the mercy of one imprudent buyer. Should one buyer pay more than he need pay for gas, his action will be reflected in the prices of any other buyers who may have bargained honestly and who have used the third-party clause. This is the reason for the much more common

use of a better-market provision reflecting the average of the three top prices. The prices paid by three buyers should represent a fair evaluation of the market, not the random action of one buyer—particularly since there are hardly ever more than ten buyers in any one area.

The common indefinite pricing provisions have been subjected to vigorous criticism on two basic grounds. First, they are said to lead to higher prices than would otherwise exist. And second, they provide only for price increases, not decreases; and these increases are irrevocable. It is with these two assertions that we shall be concerned in the remainder of this section.

The fact that prices may rise under indefinite pricing clauses is, in itself, no reason for condemning them. It has been emphasized repeatedly here that rising prices in competitive industries serve economically useful purposes. However, if indefinite price clauses lead to higher prices than would exist in their absence, economic criticism may well be justified. And it is quite possible that *with long-term contracts* in operation, a combination of favored-nations and better-market price increases in a rising market will lead to higher prices than would otherwise have existed on older contracts. However, it is not clear that such increases will lead to prices higher than would have existed *had gas been sold on a short-term basis,* as are most products. And this is the relevant criterion in examining the effects of the clauses on otherwise competitive pricing, since their very purpose is to offset any peculiar effects of the 20-year contracts.

An example of the possible working of the clauses will probably help in understanding how they can change the pattern of long-term pricing. Let us assume that there are five buyers in one area, all using both two-party favored na-

tions and better-market clauses. Three want to sell more gas in their markets and find it necessary to offer more for gas in the field than was formerly paid in order to secure the additional supplies. After paying higher prices for new gas, these lines will have to raise the prices formerly paid on their older contracts (this constitutes part of the cost of the new supply). When the next redetermination dates occur, the other two lines will raise their prices on older contracts to reflect the average action of the three lines which increased their purchases, even though the other two may have bought nothing new. Had there been no indefinite pricing clauses, the older contracts would not have been entitled to price increases. Hence more is apparently being paid for gas than would have been paid in the absence of the clauses and in the presence of long-term contracts.

On the other hand, it is quite possible that the older contracts would have started at higher prices in the absence of the protection against inflation which is provided by the indefinite pricing clauses. Part, or perhaps all, of the increase might have already been in the starting price had there been no indefinite pricing. Furthermore, if gas were sold on a short-term basis, all sellers would get more or less the same price at a given time. Differential pricing would not occur in a normal day-to-day competitive market. The indefinite pricing provisions alleviate differential pricing which results from the use of long-term contracts and which is itself a non-competitive result of such contracts. The villain is not so much the escalator as it is the long-term contract; and the escalators operate in the direction of removing a non-competitive aspect thereof.

In short, the indefinite pricing provisions promote the type of pricing which would appear in the ordinary competitive

case insofar as they lead to uniformity. However, the fact that prices become uniform as they would in the absence of long-term contracts, does not necessarily mean that they become uniform at the same *level* as would exist in the abscence of long-term contracts. The long-term contract itself may lead to higher or lower prices than would be set by a competitive market operating on a day-to-day basis.

What is the effect of long-term pricing? We can only hypothesize, but it would appear that it is nearly neutral. In the absence of long-term contracts which commit much of the gas, all present long-term sellers would be selling gas from all wells every year, not once every 20 years. Of course, the total gas reserves of the country would not be available for sale every year, since only that part of total which can be produced in one year without affecting total recovery could be sold; but all gas now committed for periods longer than one year would be salable each year at least at the present annual rate. Hence there would be a greater volume of gas available annually than is presently the case; and there would be a downward pressure on prices, relative to long-term pricing, from the selling side of the market. But there would also be greater annual requirements, since all buyers would be buying their total annual requirements each year; hence there would be an upward pressure on prices, relative to long-term pricing, from the buying side of the market. There would be more supply and more demand; and these two factors would tend to cancel each other, provided that there are a number of sellers operating at all times so that monopoly cannot exist. On balance, long-term pricing should not be unlike short-term pricing, at least insofar as initially specified prices are concerned.

The indefinite pricing provisions are designed to approxi-

mate future spot market prices; and since no such device can be perfect, there will doubtless be some deviations from what would have happened in a short-term market. However, there is no reason to believe that the deviations will necessarily be of any great magnitude if the language of the clauses is carefully drawn. The tendency toward price uniformity created by the indefinite pricing clauses is, therefore, not only in the direction of competitive pricing because it tends to make pricing uniform; it should also achieve more or less competitive price levels, unless there should be considerable defects in the wording of the clauses.

While the allegation of necessarily higher prices than would otherwise exist is of questionable validity, the criticism that the clauses are one-way streets is valid because there *are* defects in the wording of many clauses. Specifically, an indefinite pricing provision might lead to non-competitive results if spot market prices should fall in the future.[34] For example, the three highest prices in force in an area might average 15 cents at the beginning of a redetermination period. However, if spot prices had fallen to 10 cents after the higher prices were negotiated, a better-market clause based on the average of the top three prices would force the buyer to pay 15 cents to sellers on old gas when new gas was available in the market at 10 cents. Similarly, a favored nations increase is usually irrevocable once it has been granted under the terms of the contract; even if the spot price should fall thereafter, the increase will stand.

If spot prices rise above the negotiated level, there is much to be said for granting at least part of the increase to existing contracts; but if producers are to receive price increases when spot prices move above contract-specified prices, they should not expect to keep the higher prices if spot prices

move down again. Following the market price back down would be required if the indefinite pricing provision are to approximate the market. This is not to say that the clauses should be reversible to the extent of carrying the price below the initially specified level. There must be a contract floor. If there were no floor and if producers' gas is committed for 20 years, producers would be at the mercy of the buyers once their gas has been irrevocably committed. All buyers would then have a very great incentive to pay lower and lower spot prices, thereby driving down the cost of their committed gas; and the producers, bound by contract to deliver, would have no recourse. Such a situation would not only be unjust to the producer, it would also be economically unsound in that it would almost certainly lead to prices much lower than those which would occur in a competitive market, with a resultant artificial stimulation of consumption and restriction of the development of new capacity.

In fairness to the producers and pipe lines on this question of contract language, it must be admitted that the criticism is somewhat academic, in that probably no one has seriously expected gas prices to fall in the future (barring regulation which might drive down all prices). However, a decline is always possible. And some contracts, drawn to allow for all possibilities, contain escape clauses which meet the criticism. For example, redetermination may be allowed for, but it is not binding. Should, as in the example above, the pipe line believe that the spot price is actually less than a redetermined price, it may decline to pay the increase. In this event the producer has the option of selling the gas elsewhere. If he cannot find a higher price than the existing taker is willing to pay, he has no incentive to shift. If the seller can find a higher price, the existing buyer should be

willing to match it, since he will doubtless have to pay a similar price for replacement gas. In no event would the buyer be forced to increase the contract price if the actual spot price had not risen. (A variant of this clause bases the redetermined price on bona fide offers which the seller can get for the gas.) Note that these clauses do not mean that the pipe line is sacrificing its long-term supply. It will only give up the gas if replacement gas is available elsewhere for a lower price or if it is unwilling to pay the going market price. As a matter of fact it will probably not give up the gas at all, since the market is sufficiently competitive that there would doubtless be no incentive for the seller to shift his sales unless the buyer is unwilling to pay the going price, in which event the buyer should lose its supply to other buyers whose customers want the gas more acutely.

These potential defects in indefinite pricing clauses are, then, not inherent and unavoidable. They can be eliminated by the use of appropriately worded escape clauses, clauses which do not release the seller from his obligation to sell unless the buyer refuses to pay him the spot price at which the buyer would have to replace the committed gas. Since gas prices have fallen only intermittently and by small amounts since the war, no mischief has yet been done by the clauses; but mischief might be done where appropriate escape clauses are not provided should prices fall in the future.

In summary, the vigorous criticisms of the effect of indefinite pricing provisions have, in this writer's view, been much more vigorous than the subject matter deserves—unless we are willing to accept an essentially non-competitive criterion for evaluating pricing, viz., unchanging prices over long periods of time for committed gas even though the spot market price may change. The indefinite pricing provisions

are, in principle, a logical outgrowth of the use of 20-year contracts. Such contracts probably do not distort the level of prices quoted in the schedules specified at the time of sale; and carefully worded indefinite pricing provisions should allow for future fluctuations above the initially specified prices. It is not possible to permit fluctuations below this level, since there would be no consideration for long-term commitment of gas.

It should be noted in regard to the price floor that long-term contracts might some day lead to partial non-competitive pricing if future spot prices should fall below recent initially specified levels. In this event, old contracts would continue to get higher prices whereas short-term pricing would give lower prices on all sales. Fortunately this would not encourage undue expansion of capacity since the price on all new sales would be lower. This potential extra payment on old contracts is unavoidable so long as the 20-year contract is used; it is perhaps not an undue compensation to the producer for 20-year commitment of reserves, particularly in a situation of increasing demand where sharp price declines are unlikely.

CONCLUSION

It has been shown that the field market for natural gas is one of low concentration. No one firm is large relative to the market; and none is considerably larger than its competitors. In the whole interstate market from 1951-1955, the largest seller provided 7 per cent of gas sold under new contracts, the largest four sellers provided 20 per cent, and the largest 20 provided 53 per cent. The leading firms change from time to time. Concentration has decreased since World War II. And the future market will probably be widely distributed among the various sellers.

Entry into this market is not difficult. Average initial costs per productive well are about $181,000. The existing large firms have a higher success rate in terms of the number of productive wells drilled per total well drilled; but the larger firms tend to spend more on pre-drilling exploration and less on dry holes than do the smaller firms. Furthermore, it is the *size* of hits that matters most; and skilled pre-drilling exploration can do little to increase the chances of finding larger deposits, since it primarily improves the chance of finding productive structures without regard to the reserves in those structures. Ease of entry has been shown directly in the changing names and positions of the leading sellers in the concentration tables for different time periods.

While it is not possible to compute precisely the rate of return on one of a group of joint products, it is possible to determine the profitability of an average drilling program which gives only gas. On the average in recent years, the rate of return on such an endeavor would have been about 12 per cent for a going concern, not an excessive profit in a risky industry.

Prices increased rapidly in the market in the space of a

few years, beginning late in 1951. However, consumption also increased rapidly. And rising or falling prices, in themselves, do not indicate the absence of competition. There is even some feeling that stable prices in the face of increased consumption are evidence of monopolistic administered pricing. Nonetheless, prices doubled in a short period; and this may be a sufficient reason for investigating a market of low concentration somewhat more closely than would usually be necessary before concluding that there is effective competition.

The contentions that neither supply nor demand is responsive to price changes are invalid. Particularly important in this respect is the recent increase in reserves of non-associated gas in areas where gas is important. This increase has been relatively greater than the corresponding price increase.

Soft bargaining by pipe lines would constitute a significant interference with competitive pricing if such bargaining existed. Although it is impossible to determine quantitatively whether pipe lines do or do not bargain with vigor, there are a number of factors which make it difficult to believe that they do not: (1) a number of pipe line buyers are subsidiaries of distributing utilities; (2) non-integrated pipe lines deal directly in the ultimate market in some unregulated selling; (3) small field price increases are important to pipe lines relative to their over-all profits; and (4) the buying side of the market is more concentrated than the selling side, with a concomitant bargaining advantage to pipe lines.

The long-term contract has probably not as yet distorted specified prices to any significant extent from the levels that would have been achieved under short-term competitive selling. There are two relatively uncommon types of indefinite pricing clauses, the spiral and third-party favored nation, which could lead to non-competitive pricing in the

event of pipe line wage increases or imprudent purchasing by one buyer. This has not happened yet, but it might if these provisions are left in force. The common indefinite pricing provisions, the two-party favored nations and the better-market clauses, are defensible devices when spot prices are rising; indeed they tend to minimize non-competitive differential pricing. On the other hand the clauses could create non-competitive pricing if spot prices should fall in the future. This is largely a defect in contract language, and it could be corrected by more widespread adoption of the escape clauses now used in some contracts. The only inevitable portion of a long-term contract which might lead to non-competitive pricing is the necessary price floor provided by the specified price schedule; and this would occur only in a period of falling spot prices. Should spot prices fall below the specified price, the long-term contract would have protected old sellers; whereas under short-term selling their prices would also have fallen. This is perhaps not an undue price to pay for insuring a 20-year supply, particularly in view of the small chances that spot prices will fall.

On balance, the only non-competitive elements found in the market are those associated with long-term contracts. Even these would not apply for the most part unless there should be a significant decline in spot prices in the future. In the absence of a factual demonstration of widespread soft bargaining by non-integrated pipe lines, say by intensive examination of the records of contract negotiations, this writer can only conclude that there has been effective competition in the field market for gas in recent years. There is now no reason to expect anything else in the future unless spot prices should fall sharply. In this event, sales under old contracts might be at higher prices than would be the case with short-term pricing.

NOTES

1. 52 *U. S. Statutes at Large* 821, at 821 (1938).
2. *Ibid.*, p. 821.
3. *Phillips Petroleum Co. v. Wisconsin*, 347 U. S. 672 (1954).
4. See U. S. Senate, 84th Congress, Committee on Interstate and Foreign Commerce, *Hearings on S 712, etc.* (Washington, 1955) p. 1527, and 102 *Congressional Record* 1831 (1956).
5. Message of President Truman on H.R. 1758 (1950). Quoted in U. S. House of Representatives, 84th Congress, Committee on Interstate and Foreign Commerce, *Report on H.R. 6645* (Washington, 1955) p. 86 (minority views).
6. Testimony before the U. S. Senate, 85th Congress, Subcommittee on Antitrust and Monopoly Legislation of the Committee on the Judiciary, July 11, 1957.
7. U. S. House, 84th Congress, Committee on Interstate and Foreign Commerce, *op. cit.*, p. 76 (minority views).
8. M. L. Lindahl, "Federal Regulation of Natural Gas Producers and Sellers," *American Economic Review*, May, 1956, p. 541.
9. J. W. McKie, *The Regulation of Natural Gas* (Washington, 1957) pp. 30 and 31 (a publication of the American Enterprise Association).
10. M. G. Glaeser, *American Economic Review*, May, 1956, pp. 549-550.
11. M. G. Glaeser, *Public Utilities in American Capitalism* (New York, 1957) p. 598.
12. See E. S. Mason, "Current Status of the Monopoly Problem in the United States," 62 *Harvard Law Review* 1265 (1949).
13. State production data for early years are from U. S. Bureau of Mines, *Minerals Yearbook 1937* (Washington, 1937) p. 1062.
14. *U. S. v. E. I. du Pont de Nemours*, 351 U. S. 377 (1956).
15. See M. A. Adelman, "The Measurement of Industrial Concentration," *Review of Economics and Statistics*, November, 1951, pp. 272-273.
16. U. S. Federal Power Commission, "Direct Sales by Producers of Natural Gas to Reporting Interstate Natural Gas Pipeline Companies—1955" (Washington, 1956) p. 2.
17. Quoted in U. S. Senate, 84th Congress, Committee on Interstate and Foreign Commerce, *Hearings on S. 712, etc.* (Washington, 1955) p. 1258.
18. Standard & Poor's, *Oil Industry Survey*, August, 1956.
19. Union Producing is not to be confused with Union Oil of California or Union Oil and Gas of Louisiana, all separate companies.

20. Chicago Corporation recently changed its name to Champlin Oil & Refining Co.
21. U. S. Senate, 85th Congress, Subcommittee on Antitrust and Monopoly Legislation of the Committee on the Judiciary, *Concentration in American Industry* (Washington, 1957) Table 5, p. 12. The data refer to 4-digit Standard Industrial Classification industries. Note that these concentration data are based on *product* shipments by all producers of a given product, not on the total shipments of S.I.C. "industries." Hence they are not subject to the criticism of exclusion of primary products produced by other "industries" and inclusion of secondary products produced by the "industry" being studied.
22. Gas production data are released annually by the U. S. Bureau of Mines in a minerals market survey entitled "Marketed Production of Natural Gas."
23. *In the Matter of Tidewater Oil Company,* F.P.C. Docket No. G-9932, *Proceedings* (Washington, 1957), p. 1621.
24. *Ibid.*, pp. 1623 ff., esp. p. 1627.
25. This point is made, for example, in C. H. Frazier, "Cost as a Basis for Gas Field Price Fixing," *Public Utilities Fortnightly,* February 14, 1957, p. 234.
26. U. S. Federal Trade Commission, "Report on Natural Gas and Natural Gas Pipe Lines in the U.S.A.," U. S. Temporary National Economic Committee *Monograph No. 36* (Washington, 1940) p. 69.
27. See *World Oil,* February 15, 1957, p. 145. All data on total gas wells in the subsequent computation are from this source.
28. U. S. Bureau of the Census, "Crude Petroleum and Natural Gas," *1954 Census of Mineral Industries,* Preliminary Report No. MI-13-1 (Washington, 1956) Table 4, p. 10.
29. See G. B. Moody, "Exploratory Drilling in 1956," *Bulletin of the American Association of Petroleum Geologists,* June, 1957, Table IX, p. 1001.
30. Discoveries from Table III-1 (wildcat success only). Total wells from *World Oil* (see note 27).
31. American Petroleum Institute, Independent Petroleum Association of America, and Mid-Continent Oil & Gas Association, "Joint Association Survey of Petroleum Industry Income and Expenditures in the United States" (New York, 1956) p. 3.
32. See Table III-1 (wildcat success only).
33. "The Fortune Directory," pp. 18-19 (Supplement to *Fortune,* July, 1957).
34. See M. L. Lindahl, *op. cit.*, p. 542, and R. J. Gonzalez, "The Price of Natural Gas," *Southwestern Social Science Quarterly,* December, 1956, p. 266.